

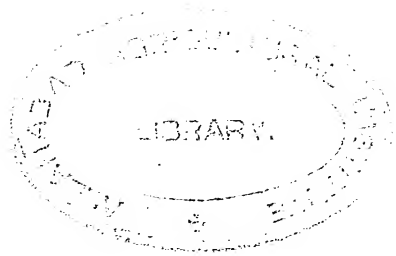


JOURNAL
OF
DAIRY SCIENCE

VOLUME I
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1918
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ANNOUNCEMENT

Although there are in the United States trade journals covering many phases of the dairy industry, there has, up to this time, been no medium for the publication of the scientific phases of the dairy industry as a whole.

The American Dairy Science Association, formerly the Official Dairy Instructors' Association, has established the JOURNAL OF DAIRY SCIENCE as the official organ of the Association and as a medium for the discussion of general and technical problems relating to the science of dairying, which confront the worker in every field of this important industry.

The JOURNAL OF DAIRY SCIENCE will publish abstracts of all papers read at the meetings of the Association and will print the most important papers and reports in full. Its columns will also be open for the publication of suitable communications by other persons, whether members of this Association or not. While it is planned to make the Journal in particular an organ for the discussion of the more fundamental and general aspects of the dairy industry, it will necessarily include many papers whose chief interest will lie in the technical problems which they present.

It will include in its scope problems in bacteriology in its relation to milk and milk products; studies in the chemistry of milk and milk products; nutrition of animals; market milk with respect to sanitation, public health and food value; scientific principles affecting the manufacture of butter, cheese, and ice cream, as well as condensed milk and milk powders, and other by-products of milk; scientific experiments and data relating to the breeding up of dairy cattle; engineering problems which relate to dairy machinery and construction; problems in cost accounting in milk production and in dairy management; new methods in laboratory technique, together with such other material as will be of value to the dairy industry as a whole.

The PUBLICATION MOVEMENT began in 1913 when the writer, in his presidential address to the Dairy Instructors' Association, made the following plea for the establishment of the JOURNAL OF DAIRY SCIENCE as the official organ of the Dairy Instructors' Association:

"In order that the association may accomplish the great tasks that lie before it, it should have the hearty support of all who are engaged in the various instructional and investigational lines of dairy work. In my estimation this can best be accomplished by some method which will give the association more prominence and publicity than it has enjoyed in the past. The American Chemical Society has built up and is able to hold its remarkable membership largely because of the activity and loyalty of those in the organization and the importance of the journal which it publishes. No chemist with a desire to keep abreast of the times would fail to retain his membership in the Chemical Society, for through it he has easy access to all the publications of the Society. This Chemical Journal affords a ready means for the immediate publication of important committee reports, special papers, abstracts and original investigations by any of its members. In my estimation, a journal published by our Association, either quarterly or monthly, would be of almost as great service to its members. It would give the Association an opportunity to publish committee reports, outlines for courses of study, and new official methods without needless delay. It would also provide for the publication of such original data as the members of the Society may care to contribute immediately upon its completion. It would also afford an excellent opportunity for the publication of such experimental work and observations as may be of interest to all engaged in this line of work, but of such nature that it may not be desirable to publish in bulletin form.

The American Chemical Journal derives its principal means of support from the advertising matter which it carries. It ought to be even easier to secure financial support for a publication which is the official organ of an association that is backed by a billion dollar industry. Additional revenue could also be derived from the regular subscription price which such a publication teeming with information on dairying would command.

Believing that a publication of this nature would be a great stimulus to all who are interested in the various branches of work undertaken by this association, I urgently recommend the appointment of a committee

to look into the desirability and feasibility of the publication of such a journal."

This met with such response that a committee was appointed to investigate the feasibility of establishing such a journal. The committee gave much study to the matter, held a number of meetings and considered numerous plans. However, it was not until the summer of 1916 when the Dairy Instructors' Association met at Amherst and again at Springfield, Massachusetts, that the committee was able to lay before the Association a proposition at once feasible and practical and which resulted in the Association authorizing its executive committee to appoint an editor-in-chief and approve committee of publication contract with the Williams & Wilkins Company for the publication of a bimonthly journal.

Change in Name of the Official Dairy Instructors' Association. In as much as the Official Dairy Instructors' Association, at their last meeting, voted to make a change in the name of the Association, your editor deemed it best to withhold the first issue of the Journal until the new name had been definitely decided upon. Dr. Harding, as Chairman of the Committee having this matter in charge, has just reported that, as a result of a post-card vote, the members of the Association have decided that in the future the Official Dairy Instructors' Association shall be known as the American Dairy Science Association.

This name, having been adopted, it seems particularly fitting that the official organ of this Association should be known as the JOURNAL OF DAIRY SCIENCE.

J. H. FRANDSEN,
Editor-in-Chief.

ADDRESS AT THE DEDICATION OF THE NEW DAIRY BUILDING AT THE UNIVERSITY OF NEBRASKA.

RAYMOND A. PEARSON

President of Iowa State College of Agriculture and Mechanics Arts

January 17, 1917

Twenty-one years ago, in 1896, your speaker was called upon to prepare a report upon dairy education in the United States. Every state was canvassed. The report published by the United States Department of Agriculture contained the following in reference to the dairy instruction equipment at the Industrial College of the University of Nebraska: "A dairy house has just been completed; it contains a large workroom and two classrooms. Apparatus consists of hand separators, deep-setting cans, and necessary utensils for making butter as in a home dairy." It was added that a twelve weeks winter farm dairy course was offered. A fee of \$1.00 was charged for this course, and it was announced that suitable board and room could be found in Lincoln at \$2.75 per week. The statement was made in the report that when the need for education along dairy lines is more clearly recognized and the good resulting from such education is better appreciated, even better facilities for instruction will be offered. This prophecy now has come true in Nebraska, and in larger measure than anyone then would have dared to hope.

We have assembled to dedicate this splendid building to the further promotion of your dairy interests. I am highly honored by your invitation to speak on this occasion.

This building means different things to different people and groups of people. To the architect it means a building that compares well with other university buildings here and elsewhere—its lines and proportions and visible materials of construction are pleasing to the eye. He has taken care to plan a

building that will be substantial and fireproof and well adapted to the peculiar needs as these have been explained by the experts.

To the builder it has a different meaning. It represents a certain cash value in materials, labor, and supervision in the form of a building 141 feet long and 64 feet wide having three stories and a basement and with a wing 60 by 70 feet having one story, and a basement. Undoubtedly it means good workmanship and undoubtedly it has meant to the builder many anxious hours caused by the exacting requirements of such a building and by the difficulties that have confronted all builders on account of changing values and prices.

To the owners, the people of Nebraska, this building represents the investment of nearly \$200,000 for the promotion of one of the most important branches of agriculture. This is a large amount of money. A good many of us will work a life time and never get within touch, sight, or hearing of a quarter or an eighth as much. But it is not a one-man building nor a four-man building nor an eight-man building but a building belonging to and adapted to serve every person in the state. Its cost is equivalent to about sixteen cents for each person in the state and nothing better could happen to this building than for each person in the state to realize that he or she has an investment here. Sixteen cents per capita in such a building as this is not very much when compared with the average amount of money spent by each person in this nation each year for candy and chewing gum,—about \$2.00. The money so used in this country in a year would be enough to erect about three such buildings as this every day in the year; the tobacco expenditures would do as much, and the liquor expenditures about four times as much more. In other words, this nation expends for liquor and tobacco and candies in a year enough money to pay for about eighteen such buildings as this every day in the year. On a pleasant summer day the insects in the United States eat up values amounting to fifty such buildings as this.

But to those citizens of the state who are especially interested, and particularly to the governing board of this university, the

chancellor, the dean, and the staff members who will use this building it means very clearly a recognition of work done and an opportunity to increase a most useful service to the state.

I desire to refer to certain phases of development in the field of dairying and in the field of education which appeal to me with much force at this time.

First, this building is a recognition of the great importance of dairying, one of the leading industries of the country. Praise for the dairy cow has been heard in the halls of congress and of legislatures. We have been told how she emigrated to the west with the early settlers, and how she has furnished milk, butter, cheese, meat, leather, glue, hair, and fertilizer; how she has lifted mortgages and provided an income when all else failed. She even has been called our "foster mother." But she never can receive all the credit that is her due.

In the United States there were in 1850, $6\frac{1}{2}$ million milch cows, 275 to each 1000 persons, and their average production was $166\frac{1}{2}$ gallons of milk per year. In 1870 there were 9,000,000 cows, 232 to each 1000 persons, with an average production of 206 gallons. In 1890 there were 16,500,000 cows, 264 per 1000 people and their average production was reported as 315 gallons per year. In 1910 there were about 22,000,000 cows, 220 per 1000 persons, and their average production was reported as 362 gallons per year. It will be noticed that the number of cows per thousand people has decreased, but this is practically offset by the increase of milk production.

In Nebraska, the development of dairying has been rapid. The United States census first reported the number of cows in this state for 1860 when there were 5 less than 7000, which was 241 per 1000 people, and the average yield was 149 gallons. In 1870, the number had increased to almost 29,000 or over 400 per cent in 10 years. There were then 235 cows per 1000 people and the average rate of production was 165 gallons per year. In 1890 the cows had increased to 505,000 in number or almost 1700 per cent in twenty years. There were then 477 milch cows per 1000 persons and the average rate of production was 287 gallons per year. In 1910 there were reported 640,000

milch cows, or 537 milch cows per 1000 persons, and their average production was reported as about 323 gallons.

In 1890 Nebraska ranked as the twenty-sixth state in population and twelfth in the number of milch cows. Since then the cow population has made relatively the larger progress.

In 1880 nearly 10,000,000 pounds of butter were made in Nebraska, and in 1910 the quantity had increased to practically 50,000,000 pounds. In 1880 almost all of the butter was made on farms, while in the last census year about one-half was made in factories. In 1896 a dairy investigator traveling through this state called attention to the advanced development of dairy farming in the eastern portion of the state, and especially the southeastern portion, and he mentioned that exceptional dairy districts were found in some of the northwestern counties. At that time much farm made butter was finding its way to the ladlers or dealers in low grade butter. The development of creameries and shipment of cream long distances have produced profound changes in the character of dairying in this entire section of the country. The number of creameries made a rapid increase when this system of butter-making was finding favor in this country. From 1880 to 1890 the creameries in Nebraska increased from 21 to 58.

It is worthy of note that the surplus of dairy products available for export has been steadily decreasing in recent years. In 1880 over 39,000,000 pounds of butter were exported. In 1890 the quantity had fallen to 29,000,000 pounds. In 1892 it was reduced to 15,000,000, and in 1913 just before the European war it was only 3,500,000 pounds. Cheese exports also have fallen off rapidly. In 1881, 147,000,000 pounds were exported; in 1891, 82,000,000; in 1901, 40,000,000; and in 1911, 10,000,000. In 1910, the exports were only 3,000,000.

These export figures tend to prove the statement that dairy products are more and more favored as a food by the people of this country. Particularly they are learning the food value of milk and consuming increased quantities. Government experts say that about 16 per cent of the ordinary American diet consists of dairy products. And these are among the cheapest

of our foods from animal sources. For example, 1 quart of milk costing 9 cents contains as much food value as 8 eggs worth 32 cents, at 48 cents per dozen; or as much as $\frac{3}{4}$ pound of ham worth 21 cents, at the rate of 35 cents per pound; or $\frac{3}{4}$ pound of beefsteak worth 18 cents, at 24 cents per pound; or 2 pounds of chicken worth 50 cents, at the rate of 25 cents per pound. And one pound of butter at 45 cents contains as much nourishment as 14 pounds of potatoes worth 48 cents, if potatoes are \$2.00 per bushel. One pound of cheddar cheese, worth 30 cents, is represented as having food value equivalent to 1.4 pounds of ham worth 49 cents, at the rate of 35 cents per pound, or 1.7 pounds of beefsteak worth 41 cents, at the rate of 24 cents per pound. More and more a variety of dairy products is being developed to cater to all tastes. Ice cream has become a popular year-round article of food. It is estimated that in the United States about 200,000,000 gallons of ice cream are consumed in a year.

The enormous business developed on account of the sale of dairy products may be imagined from the fact that the United States census reports the estimated value of the dairy products of farms (excluding home consumption) as \$656,000,000. This item may be made much larger by the addition of the dairy products not produced on farms and by attaching retail prices such as are paid by the ultimate consumer instead of wholesale prices or farm prices as reported by the census. Among the many reasons why the dairy industry deserves to be encouraged are the facts that it furnishes employment throughout the year and it builds up rather than depletes the soil. The fertilizing constituents removed from the soil in one ton of timothy hay are worth \$5.78; in one ton of clover hay, \$11.38; in one ton of wheat, \$9.59; in one ton of oats, \$9.97; in one ton of corn fodder and ears, \$8.76, and in one ton of butter, 64 cents.

Second, this building stands as a recognition of the development of dairy cows and the improvement of methods of dairying. In these respects the dairy industry has been transformed in recent years. Records of production have been made and broken repeatedly until now the largest record is held by the

Holstein cow Duchess Skylark Ormsby with a credit of 1205.09 pounds of fat; the record for Guernseys is held by Murne Cowan with 1098.18 pounds of fat; for Jerseys it is held by Sophie 19th of Hood Farm with 999 pounds 2 ounces of fat; and for Ayrshires the honor is held by Lily of Willowmoor with 955.56 pounds of fat. These figures furnish eloquent testimony as to the work of the dairy breed associations which through their systems of registry and advanced registry or other recognition for superior animals are doing much to bring up the average yield in almost every dairy district.

The great majority of cows are not pure bred and the work that is being done in connection with these animals by the dairy test associations is worthy of special mention. Mr. Helmer Rabild of the Federal Dairy Division reports 346 coöperative cow-testing associations in active operation on June 30, 1916. These associations are located in 38 different states. Their number has increased 64 per cent in the last year. Their membership reported nearly 9000 herds having slightly over 150,000 cows under monthly test. In an Iowa cow-testing association that has been in operation four years, the average production of the cows increased from 6483 pounds of milk with 246 pounds of butter fat to 8648 pounds of milk with 312 pounds of butter fat.

A Michigan association reports for six herds which have been under observation continuously for nine years an average gain of 685 pounds of milk or 51.8 pounds of fat, the average percentage of fat having increased from 3.91 to 4.29. The average profit, which is the more interesting because of large increases in cost of grain and roughage, increased from \$21.71 to \$36.13.

The advances in dairy methods include such notable changes as the introduction of the centrifugal separator, the general use of the Babcock milk test, the use of starters in butter making, the development of combined churns and workers, the perfection of methods of pasteurization, the introduction of the dairy score card, the development of the certified milk movement, the production of condensed and powdered milk, the use of milking machines, and still other improvements more or less familiar to dairymen in this state.

When discussing improvement of dairy methods, it is necessary to mention the results that have come from coöperation in manufacturing products and in making sales. The greatest progress through such organizations has been made in the little countries of Denmark and Holland. They have learned that it pays to produce good quality, and dairymen have found it to their financial advantage to combine and employ expert assistance to make tests of their products and to advise as to methods.

In all the developments that have taken place, the dairy departments of our colleges have been prominent because of their wise leadership. They have all worked together and the dairy department of this university has taken a prominent place in the progress that has been made. I am glad to give credit to Professor Frandsen for the excellent work he has rendered not only here but in a much larger field.

In the third place, this building is another evidence that the American people recognize the importance of making good provision for giving instruction in the fundamental and vital industries of our country. The state of mind of the public on this question has undergone great change in the last few years. People are coming to recognize that agricultural education is a question which concerns the general public even more than the farming classes. Our population is increasing faster than our food production. James J. Hill saw this a few years ago and prophesied that the nation would go to bed hungry within twenty years if the development of agriculture did not receive proper attention. Only three days ago an item of news was flashed over the country from Washington to the effect that our food supply has not kept pace with our growth in population. Records for the last sixteen years, the news item states, show that the population has grown about 33 per cent while there has been a decline in per capita production in foods constituting about 75 per cent of the country's diet. It is pointed out that the output of meats fell from 248.2 pounds for each person in 1899 to 219.6 in 1915, and milk fell from 95.6 gallons for each person in 1899 to 75.5 gallons in 1915. Meat and dairy products, which furnish 37 per cent of the food used on the American

table, fell from 248.2 pounds for each person in 1899 to 219.6 in 1915. Cereals, which supply 31 per cent, declined from 43.9 to 41.2 bushels.

Principal food products of export have been declining steadily. Formerly, large numbers of live cattle were exported. The average at the beginning of this century was about 500,000 per year. In 1915, less than 6000 were exported. Similar reports are made on live sheep and swine. Fresh beef, exported annually at the beginning of this century at the rate of about 300,000,000 pounds per year, fell to less than 7,000,000 in 1914. As would be expected, there was a considerable increase in 1915. Fresh pork was being exported at the rate of about 26,000,000 pounds seventeen years ago. In 1914, the quantity was less than 3,000,000. There was very little increase in 1915. Wheat was being exported at the rate of about 90,000,000 bushels per year at the beginning of this century. In 1912 the exports had fallen to 30,000,000, but they have considerably increased during the years of the war. Corn has fallen from 85,000,000 to 40,000,000 with a slight increase during the last three years. And exports of oats have fallen from about 12,000,000 to 2,000,000 bushels per year with considerable increase since the European war began. Furthermore, our imports show beef and corn from Argentina, potatoes from Europe, butter from the South Sea islands, and even eggs from China.

These are some of the reasons why bankers and lawyers and other thoughtful people who do not live on farms are coming to appreciate the importance of agricultural education. I fear the problem is much larger than most of these gentlemen appreciate. It involves profits from one's industry. The recent surveys made by government and state officials in various states have shown that a considerable number of farmers are not receiving even ordinary day wages for their labor after allowance is made for reasonable return on their capital invested. This question, together with the question of providing some of the advantages of the town to the people in the country, has a most important bearing upon the future of our agriculture. Our friends not living on the farms who have become alarmed about their future

food supply, should give careful consideration to these deeper phases of the question, for without proper attention to them the difficulties that are now becoming known cannot be remedied.

This whole matter is closely related to the attitude of the public toward the natural resources of the country. These have been exploited without regard to posterity and even without regard to our own old age.

The construction of this building is a hopeful sign. When the busy and successful people of a great commonwealth resolve to put their good money into a building where instruction will be given in dairying, it shows a conception of the whole subject of our future prosperity that is encouraging and that should be made known to the people in all states.

In New York State, with its great population, the subject of food supply has become so serious that state and city committees have been investigating, and these committees have united in a recommendation that the system of agricultural education should be strengthened and expanded. The joint recommendations contain these words:

State agencies for agricultural education and research are a prime requisite in this connection. The state should lose no time in extending the work already under way at its various agricultural institutions. We recommend that these institutions be instructed to submit plans and estimates as to what will be required to extend their facilities in the way of additional buildings and equipment and the securing of a larger staff.

The report then proceeds to show that in the United States we are far behind European countries in respect to these developments. It points out that during the last five years Norway, with a cattle population of 1,100,000, expended \$650,000 for a new veterinary college and equipment. The joint recommendation states: "We believe the time is ripe for this state to render all the aid it possibly can and offer all the inducement it possibly can to people who will engage in farming in this state. We believe that no better investment could be made on behalf of the people than appropriations by the legislature along these lines."

In the fourth place this building is another proof that the dignity of education in the industries is coming to be recognized by the American people. Here in the middle west we would naturally expect the public to regard education in agriculture as highly as equivalent education along any other line, but both east and west we still find objectors. They are a remnant of a considerable group who looked down upon education in agriculture fifty years ago and some of whom never could become reconciled to this kind of education. It is necessary that the dignity of agricultural education be recognized for three reasons:

First, because it is worthy.

Second, because unless agricultural education is so recognized it will be avoided by the ambitious, talented American boy, who is unwilling to cast his lot in a field where he might be estopped in his progress.

And again recognition *must* be given because of the splendid work in investigation and education that has commanded our attention during these recent years. I say that education in agriculture is as dignified as equivalent education in any other subject; for example, the law. To understand the sciences that relate to agriculture is to understand God's laws. Can anyone say that this is less dignified or less worthy than to be an expert in the knowledge of man's laws? Is there any reason for saying that one who understands the laws that govern the struggles of myriads of bacteria in the soil is less worthy than one who understands the laws that govern the location of line fences or trespass on top of the soil.

As to the attitude of the American boy, this was clearly described in a remarkable letter written by the Honorable Charles B. Calvert of Maryland in 1852. He was interested in a plan to establish an agricultural college and experimental farm. He wrote as follows:

The agricultural community have long felt the want of such institutions, and it is to be hoped that the present generation will do something to elevate the standing of the profession, by establishing colleges and schools, which will enable the sons of agriculturists to obtain, not only a *liberal*, but a *professional* education. The learned

professions as they are commonly termed, have engrossed most of the talent of all nations. Is it because those professions are more honorable in themselves than agriculture? Certainly not. Is it because they require more talent, learning and energy? It will not be pretended that they do. Then why is it that you find the most talented and promising sons of agriculturists, deserting the profession of their fathers for some one of these?

It is because they are endowed by nature with a certain ambitious thirst for distinction, which they feel can only be gratified by uniting themselves with some one of these professional combinations. What is the remedy necessary to remove this incubus which is consuming our vitals? Simply, education—for so soon as you give a professional, and at the same time a liberal education to the farmer, you at once arouse a professional pride to make his own the most honorable of all pursuits; and it is only necessary to arouse this pride to enable the agricultural community to take the position which their intelligence and numbers entitle them to. It cannot be denied that the agricultural community compose the great conservative power of this country—and it is impossible to disguise the fact, that we are daily departing from the great principles laid down by the wise men who formed the happy government under which we have become a great and powerful nation. We see daily combinations formed in large cities to manufacture public opinion in favor of some scheme originated solely for the benefit of some selfish individual or political party, without any regard to the great interests of the country. If, on the other hand, the agriculturists were, as a body, liberally and professionally educated, they would take that stand in the political community which their numbers and interests entitle them to, and thereby control such matters; and I therefore trust that you will see the importance of such an establishment in our state, and will give it your active support, by obtaining as many and as large subscriptions as possible.

This letter is a classic, true in its day and just as true at this time.

My argument is that agricultural education needs to be more generally recognized as dignified. I know and you know that it is dignified, and it makes a favorable comparison with any other kind of education; in fact some of our best scholars have frankly acknowledged that the whole subject of research in this country has received an impetus from the research work done

recently in the field of agriculture. One historian records the fact that the work of research in a few state universities began in their departments of agriculture. From these departments the endeavor for scholarly research extended into the departments of liberal arts and science.

Today it is amusing and sometimes sad to read of the struggle for recognition made by a few who were first to see the need and the worth of education along industrial lines. About 1840, according to Dr. Dabney in his "Education in the United States" President Francis Wayland of Brown University became interested in scientific and technical education. He wrote a book on the collegiate system of the United States and argued earnestly in favor of placing scientific subjects in the college curriculum. He succeeded in securing a science hall and a museum of geology at Brown University, but Francis Wayland was ahead of his time. Support was withheld from his scientific courses and he was forced to resign in 1855 and the old classical course was reestablished. President Wayland had studied the enrollment at New England colleges and found the number of students to be decreasing in spite of increases of endowments and reduction of tuition. He wrote:

It would seem from such facts as these that our present system of collegiate education is not accomplishing the purposes intended. Our colleges are not filled because we do not furnish the education desired by the people. . . .

We have in this country 120 colleges, 42 theological seminaries, and 47 law schools, and we have not a single institution designed to furnish the agriculturist, the manufacturer, the mechanic, or the merchant with the education that will prepare him for the profession to which his life is to be devoted.

A monument in memory of President Francis Wayland should be erected by us who believe in a magnificent dairy building upon the campus of a great university.

The early educators simply could not understand. One who was interested in Greek made an attack upon "the butter makers across the campus" for holding their subject on a par with Greek as a part of university education. But in 1896

President Walker of the Massachusetts Institute of Technology referred to the oldest university of America conferring its degree upon those who had never had an hour of either Latin or Greek within its walls and even dropping Greek from its list of entrance requirements. He says:

We get a measure of the enormous advance in educational philosophy which has taken place since President Wayland dared to challenge the opinion then universally held by the teachers and governors of American colleges and universities, that the classics were absolutely essential to liberal culture and that no one could be called well educated without them.

Members of Congress also failed to understand the situation. In 1859 Mr. Davis argued in Congress against the Morrill land grant and he said:

I have seen the growth of the proposition to do something for the agricultural interests of the country and I believe it was always delusive not to say fraudulent. It needs no aid. The agricultural interest takes care of itself and is drained to take care of every other pursuit in the country. . . . Agriculture needs no teaching by Congress. The wide extent of the country, the great variety of its soil and climate and products render it impossible that there should be anything else than local teaching in relation to agriculture.

Times have changed. The man who teaches cow test association work and how to conduct egg laying contests is coming to be looked upon throughout the length and breadth of the land with as much respect as the one who teaches arithmetic, physics, or grammar. All these subjects are important, all are vital. The American boy now will make no mistake in selecting the one which appeals strongest to his individual interest.

Fifth. I have said that this building stands as evidence of the great growth of the dairy industry and the great development of dairy methods, also that it emphasizes the enlightened attitude of the people of this state toward education which is directly applicable to our chief vocations, and that it is a proof that the dignity and worth of such education are appreciated. But all this represents a look backward. If the building stood for nothing

more than what has been mentioned it would be a monument to the past. It is that and it is a starting place for the future. We dedicate it not to the past but to the future, to a service begun now and no one would venture to say how great this service will be nor how far it will extend. We are able to foresee only certain further developments along the lines already started. Much needs to be done along these lines. The problems of feeding need further study, the economy of milk production, the further development and extension of sanitary methods, and the instruction of all people as to the wholesomeness and relative cheapness of dairy products as food, with the creation of new varieties of dairy products—all these problems will receive attention in due time and doubtless investigations in this building along these lines will attract not only statewide but nationwide and worldwide attention. The job of the discoverer of new lands to subdue has been transferred to the scientist. There was a time when our nation could increase its production in any line by finding new lands that could be adapted to the purpose desired. We now have reached the time when if we would increase our production we must appeal to the scientist to show us how it can be done; to show how one acre may take the place of two, or one cow may serve as well as two.

But the scientists engaged here are likely to find themselves working upon problems that today are utterly unthinkable. We must not assume that we have reached the limit of the field of knowledge. Surprises are in store for us now the same as they were in store for us thirty or forty years ago. Who then could have had imagination enough to foretell the developments which we have witnessed, and these are no more remarkable in the field of engineering than in the field of agriculture. Forty years ago a thoughtful business man remarked to some friends that the time would come when street cars would be driven by electricity. His prophecy was received with laughter. Can you imagine the surprise of the young Dutchman who first made a lens and through it saw forms of life which no one knew existed? Steadily our scientists are opening up new worlds. We cannot think that the last word has been said in the development of

dairy science. Experiments being conducted at the Wisconsin experiment station suggest a wonderful development in dairying. Two scientists have been studying the differences between milk fat and other kinds of fat. They have carried a little farther some studies that to a layman seem quite mysterious. It may be that their work will mark another epoch in dairying, but it is useless to attempt to foretell the future.

The greatest need of our world today is big men with big ideas. This need is felt in every field. Here you have laid a broad and firm foundation for the development of such men in the field of dairying. Such men and others similarly trained in other fields will control the future of our country. They will stand a little higher and see a little farther than their fellowmen. Like the pilot who stands on the highest point of the ship with his head just above the fog which blinds the people on the decks below and who is able to see clearly the course that should be followed, so these trained men located in this building and their students located in all parts of the state will be the leaders in attacking new problems and overcoming new difficulties and thus will help the people of Nebraska to maintain and further advance their high standing at home and the high standing of their state among her sister states.

To such high purposes this building is solemnly and reverently dedicated.

A PRELIMINARY REPORT ON A SERIES OF COÖPERATIVE BACTERIAL ANALYSES OF MILK¹

R. S. BREED

Geneva, New York

AND

W. A. STOCKING

Ithaca, New York

[Analytical work done by A. M. Besemer, H. M. Pickerell, T. J. McInerney, and G. C. Supplee of the New York State College of Agriculture at Ithaca; and R. S. Breed, J. D. Brew, H. J. Conn, W. D. Dotterer, and G. L. A. Ruehle of the New York Agricultural Experiment Station.]

Some of you will remember the report which Prof. H. W. Conn gave of the results of the extensive series of analyses which had been carried out in New York City in 1914-15 under his direction. Lest you have forgotten let me read you the conclusions² which he reached after the first series of analyses had been completed.

"1. Under the ordinary conditions of laboratory analyses, results of different laboratories in analyzing two different samples from the same bottle of milk cannot be relied upon as giving any close approximation to accuracy.

"2. Single analyses of milk samples cannot be relied upon. Not only is every laboratory liable to make some unrecognized slip in technique, so as to give a single widely divergent result, but even where there are no palpable errors, individual results occasionally diverge noticeably from the general average. Hence, no milk analysis should be reported upon except as the average of two or more tests. If four or five analyses are made, the results may be regarded as mod-

¹ Paper read before the Laboratory Section of the American Public Health Association at Cincinnati, October 24, 1916.

² H. W. Conn, Standards for determining the purity of milk, U. S. Public Health Service, Reprint 295 from Public Health Reports, August 13, 1915. 48 pp., 1915.

erately accurate; but under ordinary conditions of laboratory work, discrepancies are so great that reliance should not be placed upon a single plate count." (p. 17.)

After further series of analyses had been carried out in an effort to improve matters by standardization of the plating technique, he wrote the following cryptic sentence as his final conclusion.

"11. In spite of all these irregularities the results with duplicate samples in the four laboratories have been found, *within certain somewhat wide limits*, fairly accurate." (p. 45.) (Italics by authors of this paper.)

In view of the fact that all of our New York State market milk, both that for New York City and that for the rest of the state, is now graded on the basis of requirements in which agar plate counts made by the standard method figure very conspicuously, the results of this series of analyses was very disconcerting to our milk producers and dealers, to say the least. Moreover, the accuracy and value of many extensive research investigations were called into question at once.

The situation seemed to call for immediate action by those of us who were entrusted with the responsibility of investigating matters of importance to the dairy interests of the state. While we were at the American Public Health Association meeting in Rochester last fall, plans were drawn up for carrying out the present series of coöperative analyses. For evident reasons it is impossible to hurry such work if it is to be done with the care necessary to produce results of value so that the present report is only preliminary. The results secured, however, are of such general importance that we feel justified in presenting them.

PLAN OF WORK

The first work done was to carry out a series of analyses to determine whether the results secured in our laboratories by university men who were trained in research methods were as irregular as those secured in the commercial and control lab-

oratories who had joined efforts in New York City. To this end, four sets of samples of five each were analyzed by seven men, four working in the Ithaca laboratory (one of these a Geneva man working at the time at Ithaca) and three at Geneva. The samples were sent alternately from Geneva and Ithaca, train connections being such that the samples were ready for analysis within two or three hours after they were prepared. Each man was told to use such technique as he felt would give accurate results.

The summary in Table 1 will show the most important results secured.

COMMENTS

Plate counts

Technique. It is interesting to note that not one of the analysts was willing to use the incubation temperatures recommended by the Committee on Standard Methods (two days at 37°C.) All used prolonged incubation at two or more different temperatures. Four used a plain agar similar in composition to standard agar; the others used agars containing lactose or lactose and dextrose. One used a whey agar. In some cases the reaction of the media was adjusted, in other cases, it was not adjusted. Some clarified with egg or egg albumen. Others did not clarify. Four used pipettes with a single graduation mark, the others used pipettes with two graduation marks. There were many other variations in the details of making dilution, etc. All used three different dilutions and not one was willing to make fewer than triplicate plates from each. All microscopic counts were made in duplicate.

Table 2 has been drawn up in order to compare the variations in counts found in this series with those found in an equal number of the analyses made in New York City, the latter being selected in a random way from similar counts given in the second table of Professor Conn's report.³ Bold faced type has been used to indicate the counts which show the greater variation.

³ Loc. cit.

TABLE 1

Summary of the first series of cooperative milk analyses. Cornell-Geneva, 1915. Twenty samples analyzed by seven men (four at Ithaca, three at Geneva). Counts made by agar plate method, each man being allowed to use such technique as he thought would give the most accurate results. Counts also made by the direct microscopic method. All petri plates and smears recounted by a second person. Plated in triplicate, smeared in duplicate

SAMPLE NO.	AGAR PLATE COUNT	MICROSCOPIC COUNT		AVERAGE SIZE GROUP	NOTES
		Groups	Individuals		
1	10,200	18,700	52,000	2.8	Geneva station milk. Kept at 50° F. for 15 hours.
2	10,600	19,700	92,100	4.7	Geneva station milk. Kept at 50° F. for 27 hours.
3 and 5	6,000	5,030	7,920	1.4	Geneva station milk. Kept at 50° F. for 39 hours.
4	42,100	41,300	145,000	3.5	Geneva station milk. Kept at 50° F. for 51 hours.
6	88,500	46,400	185,000	4.0	Ithaca market milk. Iced for 24 hours.
7	72,300	46,800	201,700	4.3	Ithaca market milk. Iced for 24 hours.
8	30,500	51,500	207,600	4.0	Ithaca market milk. Iced for 24 hours.
9	97,900	80,400	383,000	4.7	Ithaca market milk. Iced for 24 hours.
10	285,000	94,000	721,000	7.7	Ithaca market milk. Iced for 24 hours. Numerous groups of bacteria containing from 10 to 400 individuals.
11	51,550,000*	93,190,000	99,480,000	1.06	Fresh milk heavily inoculated with a culture of long-rod lactic acid-bacteria from cheese whey.

12	47,600,000	49,900,000	67,450,000	1.3	Fresh milk heavily inoculated with colon bacillus.
13	135,090,000	40,200,000	162,816,000	4.0	Fresh milk kept at 37°C. for 24 hours. Scattered groups of micrococci of very large size.
14	9,867,000	5,930,000	150,200,000	25.3	Market milk containing masses of long-chain streptococci.
15	1,982,000,000†	1,531,000,000	2,680,000,000	1.7	Milk souring normally with Bact. lactis acidi. Some samples curdled.
16	120,700	69,130	391,500	5.8	Ithaca market milk. Iced for 24 hours. Few streptococcus chains.
17	25,700	12,600	233,900	18.6	Ithaca market milk. Iced for 24 hours. Scattered large clumps of long-chain streptococci.
18	1,890‡	11,970	34,480	3.0	High-grade Ithaca market milk.
19	11,754,000	8,392,000	28,407,000	3.4	Ithaca market milk. Numerous groups 10 to 50 individuals.
20	5,644,000	5,238,000	26,599,000	5.1	Ithaca market milk. Many groups larger than 10 individuals.

* Counts low and irregular because organism did not grow well.

† Overcrowded plates.

‡ Too great dilution used.

The whey agar counts made by one of the Cornell men in the Cornell-Geneva series have been disregarded as they were markedly irregular.

In tabulating the results of the Cornell-Geneva counts it was found that a few large errors had been made simply through carelessness in arithmetic. These have been corrected in the figures given. The New York City figures are just as reported

TABLE 2

Maximum and minimum plate counts obtained in the Cornell-Geneva series compared with similar counts selected from the New York City series

CORNELL-GENEVA COUNTS				NEW YORK CITY COUNTS			
Sample No.	Minimum	Maximum	No. of analyses	Sample No.	Minimum	Maximum	No. of analyses
1	2,300	14,550	15	35P	1,200	9,500	7
2	6,300	16,000	16	24P	500	15,200	8
3 and 5	4,100	7,650	22	5C	1,200	6,700	7
4	28,000	87,200	6	40R	14,000	150,000	7
6	24,000	120,000	10	49R	24,000	126,000	8
7	26,500	122,600	10	39R	30,000	250,000	8
8	15,600	44,500	10	42R	6,000	200,000	7
9	90,000	150,000	10	56R	11,000	260,000	12
10	137,000	427,000	10	48R	52,000	1,470,000	8
11-15	Omitted as these were not random samples.						
16	69,000	1,490,000*	11	600P	72,800	3,200,000	11
17	6,800	38,700	11	45C	11,800	22,400	6
18	700	5,000	11	25P	300	4,200	8
19	7,630,000	18,470,000	11	700S	2,200,000	165,000,000	7
20	1,410,000	9,550,000	11	650R	700,000	40,000,000	11

* Plates apparently contaminated. Next highest count 202,000.

Bold faced type is used in each case to indicate which pair of counts shows the widest variation.

to Professor Conn and show evident arithmetical errors. On the other hand it should be noted that the Cornell-Geneva counts were made with very diverse technique while the New York City counts were all made by the standard method. In any individual case there were almost twice as many counts made in the Cornell-Geneva series from which to select these maximum and minimum counts.

If we use the limits of 10,000, 60,000, 200,000, and 1,500,000, the counts used in our New York State grading system, then there would have been nine cases of inconsistency in the grades given in the Cornell-Geneva series. None of these inconsistencies would have caused a raising or lowering of the classification of the milk by more than one grade. There would have been nine inconsistencies of grade in the New York City counts, five of these being enough to raise or lower the grade by two classes. A study of the three instances where the variation was greater in the Cornell-Geneva series (Nos. 1, 17, 18) shows that this was due, not so much to a poor showing by the Cornell-Geneva men as because of the fact that the New York City laboratories made an especially good showing on the corresponding samples. In the one case where the research men made a poor showing because of a set of apparently contaminated plates (No. 16), the showing in the corresponding sample was, by chance, more than twice as bad for the New York City laboratories.

It would appear from this that research men using their own technique may be depended upon to secure very much more consistent counts than laboratory assistants in commercial and control laboratories, working rapidly and using standard methods. However, even the results secured by the research men cannot be regarded as ideal.

The maximum count in the Cornell-Geneva series was reported by Cornell men 12 times; by Geneva men 7 times. The minimum count was reported by Cornell men but once, by Geneva men 18 times. Among the possible explanations of the lower counts secured by the Geneva men is the fact that the Cornell men all used sugar agars while the Geneva men used plain agars; also the fact that the two laboratories use different forms of 1 cc. pipettes. A similar but not so pronounced effect occurred in the second series of analyses where all analysts used the same lot of agar. In a third series of 21 analyses of market milk and cream samples (not reported upon here) made by two men, one from Geneva and one from Cornell where both used the same lot of agar but

different pipettes as before, the Cornell man secured the higher count 15 times, the Geneva man 5 times, while one count was identical. Further tests are being planned in order to locate the cause of this elusive discrepancy. It is the more interesting because it is exactly similar to conditions noted by Professor Conn.

Microscopic counts

Technique. Only three of the men who made the microscopic counts can be regarded as experienced men so far as this technique is concerned, a fact which must be kept in mind in studying the results. Difficulties were met with in defining clumps and individuals and no perfect system was devised. Some men used the whole field of the microscope as a counting area while others used the much more satisfactory areas secured by the use of the special ocular micrometers described in Technical Bulletin 49.⁴

Forty-eight out of seventy-one of these maximum and minimum counts were reported by the four inexperienced men. As would be expected from the mathematical relations involved, the counts of individual bacteria show greater variation than the counts of groups of bacteria.

The average clump or group of bacteria contained from 1.4 to 7.7 individuals in the market milks, except in two instances where the presence of masses of long chain streptococci brought the average up to 18.6 and 25.3 respectively. The largest groups seen were masses of micrococci (presumably udder micrococci) which were found in sample No. 13. This was a high grade milk which had been incubated at 37°C for twenty-four hours, thus favoring the growth of udder forms. The masses were really compact colonies containing thousands of individuals.

Comparison between plate and microscopic counts

If the plate and microscopic counts are compared (see table 1), it at once becomes evident that the plate count does not

⁴ Robert S. Breed and James D. Brew. Counting bacteria by means of the microscope. N. Y. Agr. Exp. Sta., Tech. Bul. 49, 31 pp., 1916.

compare exactly with either of the two counts made with the microscope. It corresponds more closely with the count of clumps of bacteria than with the count of individuals, but the comparison is not an exact one, chiefly because in the making of plates, the clumps of bacteria are broken up to a certain amount by the shaking and diluting of the sample. If the individual bacteria could be completely disassociated by this process and all grew into colonies the plate count would correspond to the count of individuals. With conditions as they are, the plate count is, under ordinary conditions, a count usually larger than the group count and much less than the count of individuals. However, the matter is complicated by the presence of bacteria which do not grow on plates, dead bacteria, and occasionally other things which frequently change this relationship.

In six instances, the plate count was less than the group count. In one of these (12), the difference was so slight as to be negligible; in another (11), the reason for it was clearly because of the presence of living bacteria incapable of growth on agar. The other four instances were of low count milks (1, 2, 8, and 18) where there may have been udder bacteria not capable of growth or dead bacteria killed by the cooling of the milk.

An examination of the maximum and minimum counts shows that less extreme variations were found in the series of plate counts made by the Cornell-Geneva men (table 2) than in any of the other 3 series. Also that the amount of variation found in the group counts (table 3) was approximately the same as that found in the series of plate counts made in New York City (table 2), while the amount of variation in the counts of individuals (table 3) is relatively enormous.

A superficial judgment would incline to the view that this fact shows the inferiority of counts made by the microscopic method. But there is more to the matter than appears on the surface. As a result of our studies, we are convinced that, with carefully standardized technique and well trained men, the amount of variation found in plate counts and in group counts

by the microscopic method would be approximately the same, though further studies are necessary before this fact can be regarded as established. The greater variations in counts found where counts of individuals are made, are due, not so much to faulty technique or inexperience of the analysts, as to the fact *that these counts give a faithful picture of the real conditions*. In other words, the greater regularity of the plate and

TABLE 3

Maximum and minimum group and individual counts obtained in the first Cornell-Geneva series of analyses.

Sample No.	COUNT OF GROUPS		COUNT OF INDIVIDUALS		TOTAL NO. COUNTS
	Minimum	Maximum	Minimum	Maximum	
1	5,000	35,000	6,000	123,000	11
2	2,700	57,000	2,700	306,000	11
3 and 5	Less than 3,000	21,000	Less than 3,000	114,000	17
4	1,800	120,000	3,600	528,000	11
6	9,000	1,090,000	21,000	5,567,000	10
7	9,000	93,100	96,000	316,000	10
8	4,500	190,000	4,500	721,000	10
9	18,200	180,000	61,000	950,000	10
10	29,500	184,500	129,000	1,362,000	10
11	74,500,000	126,044,000	74,560,000	126,044,000	14
12	32,500,000	88,200,000	44,820,000	120,600,000	14
13	14,850,000	68,819,000	109,140,000	297,210,000	14
14	2,983,000	13,127,000	61,500,000	302,694,000	14
15	667,200,000	2,675,000,000	1,302,000,000	5,350,000,000	14
16	9,000	131,250	63,000	900,000	14
17	3,000	33,000	Less than 5,000	1,140,000	14
18	Less than 5,000	60,000	Less than 5,000	141,000	14
19	1,120,000	23,750,000	6,300,000	86,487,000	14
20	1,625,000	13,435,000	13,700,000	55,080,000	14

Bold faced type used to show the counts which had the greater variation.

group-counts is in reality due to their being counts of groups of bacteria, while the irregularity of the counts of individuals is due to irregularities in the numbers of individuals in the clumps. In order to overcome the variations caused in this way, it would be necessary to examine a much larger amount of milk than is ordinarily examined when making counts by the microscopic method.

SECOND SERIES OF ANALYSES

Because of the consistent counts obtained on sample 12 (containing the colon bacillus), as well as similar results secured at other times, it was decided to carry out a second series of analyses on samples of milk containing the colon organism, trying at the same time to eliminate all probable sources of errors in count. The colon organism was chosen because it tends to grow singly or in pairs, is always found evenly distributed throughout a sample of milk, and grows well on all media at all ordinary incubation temperatures.

In order to have a series of checks and counter checks on the accuracy of the counts, it was decided to use but three lots of milk, analysing each in triplicate. These were prepared by inoculating one liter of a high grade milk with 2.5 cc., 5 cc. and 10 cc. quantities, respectively, of a skim milk culture of the colon bacillus. Thus the counts obtained from the samples were expected to show the ratio 1:2:4.

The samples were prepared at Geneva and the results showed that they were suitable for the purposes for which they were designed. In one respect they were not as perfect as those used for No. 12 in the earlier series, as it was found that masses of the organisms had formed in a thin film of cream which rose to the surface of the skim milk culture used for inoculation, so that occasional masses of bacteria appeared in the final samples which contained 10 to 30 or even more individuals.

Counts were made from these samples by the plate method, by the dilution method, and group and individual counts by the microscopic method. In making counts by the dilution method, 1 cc. quantities of suitable dilutions were added to sterile milk tubes in triplicate. These were then incubated for three days at 37°C. and then examined for growth. As these counts were made by one person only they cannot be regarded as having equal value with the other counts.

The results are summarized in table 4.

COMMENTS

Plate count

The most noticeable feature of the plate counts was their great regularity. The two highest and two lowest counts are given for each sample in table 5.

TABLE 4

Summary of second series of cooperative milk analyses. Cornell-Geneva, 1916. Ten samples analysed by six men (three at Ithaca, three at Geneva). Agar plate-technique standardized. One lot of agar used by all. (1 per cent Difco-peptone, 1 per cent lactose. 0.5 per cent Liebig's beef extract, 1.5 per cent agar). Microscopic counts as before. All petri plates and smears recounted by a second person. Dilution counts made by one man at Geneva. Plated in triplicate, smeared in duplicate

SAMPLE NO.	AGAR PLATE COUNTS	MICROSCOPIC COUNT		AVERAGE SIZE GROUP	DILUTION COUNT	NOTES
		Groups	Individuals			
1	390	3,000*	4,000*	1.3	Less than 100	Fresh milk drawn into a sterile pail.
2-4	397,000	262,000	476,000	1.8	About 300,000	One liter from Sample 1 to which 2.5 cc. of a skim milk culture of the colon bacillus had been added.
5-7	639,000	513,000	809,000	1.6	Less than 600,000	As above 5 cc. colon culture added.
8-10	1,381,000	995,000	1,570,000	1.6	Between one and two million.	As above 10 cc. colon culture added.

* Counts made by inexperienced men were omitted in computing these averages.

Theoretical ratio, 1: 2: 4.

Actual ratios: Plate-count, 1: 1.61: 3.48; group-count, 1: 1.96: 3.80; individual-count, 1: 1.70: 3.30; dilution count, 1: 2: 4±.

Troublesome spreaders were practically absent from the agar plates and they were in excellent shape for counting at the end of three days incubation. All counts were made from plates having more than 30 and less than 300 colonies per plate.

There were no cases where the recount of plates by a second person showed any marked discrepancies.

Microscopic counts

The microscopic counts were less regular than the plate counts. The effect of experience in counting by this method was very noticeable, 13 out of the 32 extreme counts noted in table 5 having been reported by the only man in the group who had not participated in the previous series of analyses. It was very clear also that the inexperienced men mistook objects for bac-

TABLE 5

Maximum and minimum counts obtained in the second Cornell-Genova series

SAMPLE NO.	PLATE COUNT		MICROSCOPIC COUNT				TOTAL NO. COUNTS
	Minimum	Maximum	Groups		Individuals		
			Minimum	Maximum	Minimum	Maximum	
1	190	1,000	000	283,000	000	447,000	12
	220	570	000	298,000	000	380,000	
2-4	299,000	420,000	45,000	500,000	97,000	1,841,000	36
	301,000	405,000	97,000	458,000	131,000	1,748,000	
5-7	453,000	790,000	72,000	774,000	198,000	1,641,000	36
	453,000	767,000	186,000	765,000	308,000	1,116,000	
8-10	1,126,000	1,740,000	434,000	1,623,000	656,000	2,658,000	36
	1,140,000	1,636,000	570,000	1,477,000	745,000	2,586,000	

teria which were not bacteria in counting sample 1. This was in reality a high grade milk containing very few bacteria as shown by the plate counts, the dilution counts, and by the microscopic counts made by the experienced men. In some cases the inexperienced men found more bacteria in this milk, which was used as the base for the preparation of samples 2 to 4, than they did after the colon bacilli had been added to it. The most probable explanation is that the inexperienced men mistook stained particles for bacteria and counted them in sample 1. In samples 2 to 4, where unmistakable bacteria were present

in nearly every field of the microscope they disregarded these stained particles and in some instances clearly overlooked the bacteria. In other cases they found large masses of bacteria none of which were reported by the experienced men. All of these effects are chargeable to inexperience rather than to carelessness and were apparently little greater than similar effects noted where inexperienced men are set at the task of counting agar plates.

The amount of this effect produced by the inexperience of the men may be roughly gauged by comparing the maximum and minimum counts in table 6 with those in table 5.

TABLE 6

Maximum and minimum microscopic counts obtained by the experienced men in the second Cornell-Geneva series.

SAMPLE NO.	GROUPS		INDIVIDUALS		TOTAL NO. COUNTS
	Minimum	Maximum	Minimum	Maximum	
1	000	12,000	000	18,000	6
	000	3,000	000	3,000	
2-4	165,000	306,000	258,000	585,000	18
	189,000	315,000	333,000	552,000	
5-7	348,000	765,000	647,000	1,641,000	18
	417,000	627,000	762,000	1,116,000	
8-10	740,000	1,623,000	1,506,000	2,658,000	18
	703,000	1,477,000	1,428,000	2,586,000	

The largest of these variations were evidently caused by differences in counting rather than in differences in smears as some of the widest of them occurred in the recounts of the same smears by different persons.

Dilution counts

As was to be expected, the dilution counts gave results which corresponded in a general way with those obtained by the other methods.

Comparison of plate and microscopic counts

It is only when the plate and microscopic counts are compared that the most important conclusions can be drawn. When the final averages were computed it was found that these counts met all of the checks and counter checks which had been placed upon them, in a remarkable way. Samples 2 to 4 gave average plate and microscopic counts slightly less than one-half of those from samples 5 to 7 and likewise slightly less than one-fourth of those from samples 8 to 10. Samples 5 to 7 gave plate and microscopic counts slightly less than one-half of those from samples 8 to 10 (see table 4.) The group count met this check the most perfectly of any of the three counts, while the plate counts and individual counts met it about equally well. For some reason which is not evident, the counts made on samples 2 to 4 were proportionately the largest in all cases. The average plate counts were always in excess of the group counts and less than the individual counts, as would be the case if the conditions were as postulated; namely a milk containing living organisms, with but small groups and all of the organisms capable of growth on the agar at the incubation temperature used.

In view of these facts, it can scarcely be doubted that we have here for the first time, adequate proof that the mechanical perfection of both the plate method and the microscopic method is sufficient to produce reasonably accurate results in the hands of experienced men, provided the nature and the distribution of the bacteria in the samples of milk is such that accurate counting is possible.

CONCLUSIONS

1. Research men, using technique which differs much in details, may be depended upon to secure much more consistent agar plate counts from ordinary samples of market milk than laboratory assistants working rapidly and using the routine methods of analysis recommended for the purpose.

2. Inexperienced workers are apt to make gross errors in count when using the direct microscopic method as a means of

making exact counts. Experienced workers however secure results which compare favorably with those secured by workers who have had experience with the plating technique.

3. The labor and time necessary in order to make relatively accurate counts by either method is much greater than that ordinarily employed in making counts in laboratories where large numbers of routine analyses are made.

4. In making comparative counts with the plate and microscopic methods, the agar plate counts will normally be larger than the counts of groups of bacteria by the microscopic method and smaller than the count of individual bacteria; but many things may change this relationship in individual cases. Among these things are inaccuracies in the counts due to exceptionally irregular distribution, the presence of dead bacteria or of living bacteria incapable of growth on the agar used.

5. Where a milk contains nothing but living bacteria occurring singly, (or at least with only a relatively small number of groups containing two or more individuals) all of which are capable of growth on the agar used, very consistent counts can be made by either method from duplicate samples by the same or by different persons. In such cases the relation between the counts is such as to leave little doubt but that the figures obtained are remarkably accurate counts of the number of groups of bacteria in the case of both the microscopic and plate method; or of the number of bacteria present in the case of the microscopic method.

REPORT OF COMMITTEE ON RELATIONS TO BREED ASSOCIATIONS

Since our last report official testing has continued to grow at a constantly increasing rate. The problem of handling it in the future is a serious one for the agricultural colleges. The committee is pleased to report a marked improvement in the methods of conducting of official tests as a result of the efforts of this committee and this association to standardize official testing and to stimulate those responsible for its administration in the several states to more carefully supervise and safeguard the work.

Apparently most of the states, especially where a considerable amount of testing is done, on the whole, have the situation well in hand. In a few states, from the information at hand, the present management of official testing reflects no credit on the man and institution responsible, and certainly does not add to the professional standing of teachers and investigators in agricultural lines.

The practical man will not have much respect for an institution that tests his cows three days, then allows him to select and report the two best days, or if he is allowed to milk cows on two sides of a barn at the same time, or if the tester has the milker take samples. Authenticating the records of a cow test association when the college has no control whatever of the tester may please the breeder concerned but certainly does not increase the prestige of the college or experimental station. All these practices and some others have come to the attention of members of the committee.

In May, 1916, the chairman of the committee sent a questionnaire to the superintendent of official testing in each state asking:

1. If the rules for the supervision of official testing as adopted by the Dairy Instructors' Association are followed.

2. If the recommendations of the association regarding the number of cows a tester is allowed to test at a time is followed.

3. If records of cow test associations are authenticated.

The replies showed that the rules for the supervision of tests as adopted by the association are followed in detail by nineteen states including most of those where the largest amount of testing is done. Four others follow the rules with the exception that the composite sample is omitted and five others follow the Breed Association rules concerning preliminary milkings. Nine states follow the rules of the breed associations without regard to the recommendations of the Dairy Instructors' Association.

Concerning the authentication of cow test association records no uniform practice as yet exists. The majority of the states are doing more or less of it although the testers are generally appointed by the Agricultural College. It should be said, however, that most of the states doing a large amount of official testing; namely, New York, Illinois, Wisconsin, Michigan, Pennsylvania, Massachusetts, and Indiana, do not authenticate such records.

The replies to the third inquiry show that in most states the number of cows the tester is allowed to test is limited to that recommended by the association, or to a number substantially the same. In some cases the number allowed seems entirely too high. A report has come to the committee that in one state a tester has been allowed to test as many as fifty cows in one day.

The following recommendations were made by the committee and received the approval of the association:

1. That the person in charge of official testing within a state be termed "Superintendent of Official Testing" and the representative of this official who does the testing be termed the "Supervisor" and ask the breed associations to adopt these terms.

2. That the secretary of this association be authorized with the assistance of the chairman of this committee to prepare forthwith a report giving all resolutions and reports on official testing adopted by this association, and further that this mate-

rial be published in pamphlet or mimeograph form at the expense of the association and distributed to all colleges and experiment stations.

3. We ask those dairy breed associations which have not already done so to recognize the rules for official testing as adopted by this association and to include them in their publications.

4. With reference to authenticating records of cow test associations:

It is the sentiment of this body that records supervised by cow testing association employees should not be authenticated unless the supervisor be selected and employed by the Superintendent of Official Testing in that state, and that the work be done in strict accordance with the rules adopted by the Official Dairy Instructors' Association for the conduct of official tests, and further that even in states where cow testing association records are authenticated under these conditions the practice should be discontinued as promptly as more satisfactory arrangements can be made.

This committee further recommends that no person be allowed to act as supervisor in official test work who is not at the time in the employ of, and receiving his directions and compensation from the superintendent of official testing for that state.

5. We ask that the different breed associations recognize only one superintendent of official testing in each state.

Committee,

H. H. WING, Cornell,

E. G. WOODWARD, Neb.,

R. T. HARRIS, Wis.,

G. S. BULKLEY, Pa.,

H. E. VAN NORMAN, Calif.,

C. H. ECKLES, Mo., *Chairman.*

SPECIFICATIONS AND DIRECTIONS FOR TESTING MILK AND CREAM FOR BUTTERFAT

O. F. HUNZIKER

*Chairman Committee on Official Methods of Testing Milk and Cream for Butterfat
Official Dairy Instructors' Association, 1916*

I. APPARATUS AND CHEMICALS

Milk test bottle.—8 per cent 18 gram milk test bottle, graduated to 0.1 percent. Graduation. The total per cent graduation shall be 8. The graduated portion of the neck shall have a length of not less than 63.5 mm. ($2\frac{1}{2}$ inches). The graduation shall represent whole per cent, five-tenths per cent and tenths per cent. The tenths per cent graduations shall not be less than 3 mm. in length; the five-tenths per cent graduations shall be 1 mm. longer than the tenths per cent graduations, projecting 1 mm. to the left; the whole per cent graduation shall extend at least one-half way around the neck to the right and projecting 2 mm. to the left of the tenths per cent graduations. Each per cent graduation shall be numbered, the number being placed on the left of the scale.

The maximum error in the total graduation or in any part thereof shall not exceed the volume of the smallest unit of the graduation.

Neck. The neck shall be cylindrical and of uniform internal diameter throughout. The cylindrical part of the neck shall extend at least 5 mm. below the lowest and above the highest graduation mark. The top of the neck shall be flared to a diameter of not less than 10 mm.

Bulb. The capacity of the bulb up to the junction of the neck shall not be less than 45 cc. The shape of the bulb may be either cylindrical or conical with the smallest diameter at the bottom. If cylindrical, the outside diameter shall be be-

tween 34 and 36 mm.; if conical, the outside diameter of the base shall be between 31 and 33 mm., and the maximum diameter between 35 and 37 mm.

The charge of the bottle shall be 18 grams.

The total height of the bottle shall be between 150 and 165 mm. ($5\frac{7}{8}$ and $6\frac{1}{2}$ inches).

Cream test bottle 1.—50 per cent 9 gram short-neck cream test bottle, graduated to 0.5 per cent. Graduation—The total per cent graduation shall be 50. The graduated portion of the neck shall have a length of not less than 63.5 mm. ($2\frac{1}{2}$ inches). The graduation shall represent 5 per cent, 1 per cent, and 0.5 per cent. The 5 per cent graduations shall extend at least half-way around the neck (to the right). The 0.5 per cent graduations shall be at least 3 mm. in length, and the 1 per cent graduations shall have a length intermediate between the 5 per cent and the 0.5 per cent graduations. Each 5 per cent graduation shall be numbered, the number being placed on the left of the scale.

The maximum error in the total graduation or in any part thereof shall not exceed the volume of the smallest unit of the graduation.

Neck. The neck shall be cylindrical and of uniform internal diameter throughout. The cylindrical part of the neck shall extend at least 5 mm. below the lowest and above the highest graduation mark. The top of the neck shall be flared to a diameter of not less than 10 mm.

Bulb. The capacity of the bulb up to the junction of the neck shall not be less than 45 cc. The shape of the bulb may be either cylindrical or conical with the smallest diameter at the bottom. If cylindrical, the outside diameter shall be between 34 and 36 mm.; if conical, the outside diameter of the base shall be between 31 and 33 mm. and the maximum diameter between 35 and 37 mm.

The charge of the bottle shall be 9 grams. All bottles shall bear on top of the neck above the graduations, in plainly legible characters, a mark defining the weight of the charge to be used (9 grams).

The total height of the bottle shall be between 150 and 165 mm. ($5\frac{7}{8}$ and $6\frac{1}{2}$ inches), same as standard milk test bottles.

Cream test bottle 2.—50 per cent 9 gram long-neck cream test bottle, graduated to 0.5 per cent. The same specifications in every detail as specified for the 50 per cent 9 gram short-neck bottle shall apply for the long-neck bottle with the exception, however, that the total height of this bottle shall be between 210 and 235 mm. ($8\frac{1}{4}$ and 9 inches), that the total length of the graduation shall be not less than 120 mm., and that the maximum error in the total graduation or in any part thereof shall not exceed 50 per cent of the volume of the smallest unit of the graduation.

Cream test bottle 3.—50 per cent 18 gram long-neck cream test bottle, graduated to 0.5 per cent. The same specifications in every detail as specified for the 50 per cent 9 gram long-neck bottle shall also apply for the 18 gram long-neck bottle, except that the charge of the bottle shall be 18 grams. All bottles shall bear on top of the neck above the graduation, in plainly legible characters, a mark defining the weight of the charge to be used (18 grams).

Pipette, capacity, 17.6 cc. Total length of pipette not more than 330 mm. ($13\frac{1}{4}$ inches). Outside diameter of suction tube 6 to 8 mm. Length of suction tube 130 mm. Outside diameter of delivery tube 4.5 to 5.5 mm. Length of delivery tube 100 to 120 mm. Distance of graduation mark above bulb 15 to 45 mm. Nozzle straight. To deliver its contents when filled to the mark with water at 20°C., in five to eight seconds. The maximum error shall not exceed 0.05 cc.

Acid measure, capacity 17.5 cc.

Cream testing scales. Sensibility reciprocal of 30 mgm., i.e., the addition of 30 mgm. to the scales, when loaded to capacity, shall cause a deflection of the pointer of at least one division on the graduation.

Weights, 9 gram weights for 9 gram cream test bottles and 18 gram weights for 18 gram cream test bottles, preferably stamped correct by the United States or State Bureau of Standards.

Tester. Standard Babcock test centrifuge and speed indicator.

Dividers for measuring fat column.

Water bath for cream samples, with proper arrangement for regulating and recording temperature of samples.

Water bath for test bottles, of sufficient size and with necessary equipment to insure proper control of temperature. The following dimensions for a twenty-four bottle water bath are recommended: Metal box, 14 inches long, 11 inches wide and $8\frac{1}{2}$ inches deep and equipped with a bottle basket $9\frac{1}{2}$ inches long and $6\frac{1}{2}$ inches wide, capacity twenty-four bottles, a steam and water inlet, a drain, a thermometer holder with thermometer.

Chemicals. Commercial sulphuric acid, specific gravity 1.82 to 1.83; glymol, or white mineral oil, high grade.

II. MANIPULATION OF TEST

A. Milk Test

Milk Samples. Single samples are preferred to composite samples. If composite samples are used they should be kept in clean jars sealed air-tight, and containing a sufficient amount of preservative. Corrosive sublimate, potassium bichromate and formaldehyde may be used as satisfactory preservatives. For the keeping of composite samples a cool location should be chosen. They should be the product of not over one week and should be tested as soon as possible.

If transported by mail, express or otherwise the sample bottle should be completely full and tightly stoppered and the samples should be preserved as above directed.

Immediately before testing the sample is thoroughly mixed until it is homogeneous. If lumps of cream, butter or ice do not completely disappear, heat to 100° to 120°F. , mix thoroughly and pipette at once. Avoid incorporation of air bubbles while mixing the sample. Curdy and churned samples are not dependable.

Testing. Measure 18 grams of milk from properly mixed sample into standard milk test bottle, by using 17.6 cc. standard pipette; add 17.5 cc. of standard commercial sulphuric acid,

and shake until all curd has disappeared, and then continue the shaking for a few moments longer. Milk and acid before mixing should have a temperature of 50° to 70°F.

Whirl in Babcock centrifuge for five, two and one minutes, respectively, filling the bottle with hot soft water (temperature 140°F. or above) to the bottom of the neck after the first whirling and to near top graduation after the second whirling. The proper speed of the centrifuge is 800 revolutions for an 18 inch diameter wheel and 1000 revolutions per minute for a 12 inch diameter wheel.

Set the test bottles into water bath and read after a temperature of 135°F. to 140°F. has been maintained for not less than 3 minutes. Read test by measuring fat column from bottom of lower meniscus to top of upper meniscus. Use dividers for reading.

B. Cream Test

Cream Samples. Cream samples should be tested as soon as possible and not later than three days after they are taken. Composite samples representing portions of consecutive deliveries of the same patron are unreliable. Samples should at all times be kept in nonabsorptive containers, sealed air-tight and held in the cold.

Immediately before testing mix the sample until it pours readily and a uniform emulsion is secured. If in good condition shake, pour or stir until properly mixed. If very thick, warm to 85°F. and then mix. In case of lumps of butter heat the sample to 100°F. to 120°F. by setting in water bath, mix thoroughly and weigh out at once. For commercial work on a large scale it is advisable to temper all samples to 100° to 120°F. in a water bath previous to mixing. Great care should be exercised to avoid overheating the sample, causing the cream to "oil off." This precaution is especially necessary with thin cream.

Testing. Weigh 9 grams or 18 grams, respectively, of the properly mixed sample into a standard cream test bottle on standard cream testing scales which are in proper working condition, set level and are protected from drafts.

Method I. Add standard commercial sulphuric acid until the mixture of acid and cream, immediately after shaking, resembles in color, coffee with cream in it. Usually about 8 to 12 cc. of acid is required in the case of the 9 gram bottle or 14 to 17 cc. of acid in the case of the 18 gram bottle, the amount needed depending on the temperature of acid and cream and on the richness of the cream.

Whirl in Standard Babcock centrifuge at proper speed, five, two and one minutes, respectively, filling the bottles with hot soft water, temperature 140 F. or above, to the bottom of the neck after the first whirling and to near the top graduation after the second whirling.

a. *Alternate Method.* Add 9 cc. of water after the cream has been weighed into the test bottle and before the acid is added, then add 17.5 cc. acid and proceed as in previous method. This method is applicable with the 9 gram bottle only.

b. *Alternate Method.* Add 8 to 12 cc. of acid in the case of the 9 gram bottle or 14 to 17 cc. of acid in the case of the 18 gram bottle, or add acid until the mixture of cream and acid, after shaking, has a chocolate brown color. After the cream and acid have been thoroughly mixed and all lumps have completely disappeared, add a few cubic centimeters (not less than 5 cc.) of hot soft water, whirl five minutes, add hot soft water to near top of scale and whirl one minute.

The proper speed of the centrifuge is 800 revolutions per minute for an 18 inch diameter wheel and 1000 revolutions per minute for a 12 inch diameter wheel.

Set the test bottles into water bath and read after a temperature of 135°F. to 140°F. has been maintained for not less than three minutes, add a few drops of glymol and read at once, preferably using dividers. Experienced testers are able to secure correct readings without glymol by reading to the bottom of the upper meniscus but the use of glymol is urged.

C. Defective Tests

The fat column of the finished test should be clear, translucent and should have a golden yellow to amber color. All

tests which are milky, or foggy, or showing the presence of curd or charred matter in or below the fat column, or of which the reading is indistinct or uncertain, should be rejected. Duplicate tests are essential in all work where special accuracy of results is required, such as in official testing and experimental investigations.

REPORT OF THE COMMITTEE ON STATISTICS OF MILK AND CREAM REGULATIONS OF THE OFFI- CIAL DAIRY INSTRUCTORS' ASSOCIATION

PRESENTED AT ITS MEETING AT SPRINGFIELD, MASSACHUSETTS,
OCTOBER 17, 1916

Committee: Mr. Ivan C. Weld, *Chairman:* Prof. E. H. Farrington, University of Wisconsin; Mr. J. A. Gamble, Dairy Division, U. S. Department of Agriculture; Prof. H. E. Ross, Cornell University; Mr. Roy C. Potts, Bureau of Markets, U. S. Department of Agriculture

In taking up a study of the milk and cream regulations of the cities and towns of the United States, the committee decided upon a classification of the cities into four groups according to their population, as follows:

Group I.....	5,000 to 25,000 population
Group II.....	25,000 to 100,000 population
Group III.....	100,000 to 500,000 population
Group IV.....	Over 500,000 population

The survey includes 194 headings and sub-headings pertaining to laws and ordinances designed to regulate the production, care and sale of milk and cream, and presents and includes a mass of statistics that we hope may be carefully studied by all members of this Association and by others.

The handling of milk supplies during milk-borne epidemics has not been included in this survey.

In compiling these data, the committee has held strictly to the exact wording in the regulations covered and has made no note of matter implied but not specifically stated.

The committee is indebted to the Market Milk Section of the Dairy Division of the Bureau of Animal Industry for the opportunity to study the milk regulations of 694 cities now on file in that office. Some of these city regulations were adopted recently. Others were adopted several years ago.

The committee is also indebted to the Department of Agriculture for much of the clerical assistance necessary for compiling the data.

Your committee has endeavored to compile the data as systematically as possible, and in a way that will make possible a comparison of the requirements of cities within a single group, and requirements of cities of one group with requirements of cities of other groups.

Complete regulations were obtained from 409 of the 694 cities represented in our study; from 62, partially complete regulations were obtained; and 223 cities reported they had no regulations pertaining to the sale of milk and cream. An exceedingly large proportion, or 218, of the cities having no regulations governing the sale of milk and cream were in the group containing from 5,000 to 25,000 population. These cities were located in 45 states, so may be considered as representative of the whole country.

Information in detail is as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of cities and towns represented in this survey.....	511	133	42	8	694
Number of cities and towns reporting no regulations.....	218	5	0	0	223
Number of cities and towns from which partial regulations were available.....	59	3	0	0	62
Number of complete regulations of cities and towns represented.....	234	125	42	8	409

PERMITS OR LICENSES

The survey shows that over half of the cities require licenses, or permits, for the sale of milk, and of these about one-third do not require the inspection of the dairy or city milk plant before

granting the license. In practically all of the cities permits or licenses are issued annually. The basis of charge for permits or licenses varies greatly, some charging a certain sum per annum, others a certain sum per wagon, others a certain sum per cow, and one city charges a certain sum for each thousand pounds of milk handled. The more common practice is to charge a specified sum per annum. This amount varies from 25 cents to \$10.00 per annum. In other cities the rate varies from 50 cents to \$10.00 per wagon, and from \$1.00 per 15,000 pounds of milk sold per month to \$20.00 per month where over 320,000 pounds of milk is sold.

Information in detail is as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of cities requiring licenses or permits for the sale of milk.....	207	105	37	8	357
Number of regulations failing to mention permits or requiring none.....	27	20	5	0	52
Number of regulations which state that permits are issued					
Annually.....	154	85	20	4	263
Semi-annually.....	7	4	3	0	14
Each three months.....	1	0	0	0	1
Monthly.....	0	1	0	0	1
Number of regulations which fail to state how often permits are issued.....	72	15	14	4	105

Charges for permits or licenses

Number of cities requiring fees.....	106	50	15	2	173
Number of cities not reporting or not requiring fees.....	128	75	27	6	236

Charges for permits or licenses—Continued

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of cities charging					
\$3.00 per month.....	1	0	0	0	1
1.00 per six months.....	1	0	0	0	1
0.25 annually.....	0	2	0	0	2
0.50 annually.....	20	7	2	0	29
1.00 annually.....	21	10	1	1	33
1.50 annually.....	1	0	0	0	1
2.00 annually.....	23	2	1	0	26
3.00 annually.....	1	1	0	0	2
5.00 annually.....	7	3	0	0	10
10.00 annually.....	3	2	0	0	5
0.50 per wagon annually.....	0	1	0	0	1
1.00 per wagon annually.....	1	4	1	0	6
2.00 per wagon annually.....	3	2	0	0	5
2.50 per wagon annually.....	0	1	0	0	1
5.00 per wagon annually.....	2	2	2	0	6
10.00 per wagon annually.....	2	0	0	1	3
\$0.50 per wagon; \$1.00 each additional wagon, annually.....	1	0	0	0	1
\$1.00 each wagon; \$0.25 each additional wagon, annually.....	1	0	0	0	1
\$1.00 each wagon; \$1.00 each plant, annually.....	1	0	0	0	1
\$1.00 each wagon; \$0.50 license.....	0	1	0	0	1
\$1.00 each wagon; \$1.00 license.....	0	0	1	0	1
\$1.00 each wagon; plant and store.....	0	2	0	0	2
\$1.50 1st wagon; \$1.00 2d; \$0.75 3d; \$0.50 4th.....	1	0	0	0	1
\$2.00 1st wagon; \$0.50 each additional wagon.....	1	1	0	0	2
\$2.00 per wagon each 6 months; \$0.50 each additional wagon.....	1	0	0	0	1
\$2.00 1st wagon; \$1.00 each additional wagon.....	1	0	0	0	1
\$2.00 per wagon; \$1.00 each store.....	0	1	2	0	3
\$2.00 per wagon; \$2.00 additional wagon...	0	0	1	0	1
\$2.00 per wagon; \$3.00 permit.....	0	0	1	0	1
\$2.00 per wagon; \$2.00 per cow; \$5.00 license.....	0	1	0	0	1

Charges for permits or licenses—Continued

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of cities charging					
\$2.50 per wagon; \$1.00 pushcart; \$0.50 hand carried.....	1	0	0	0	1
\$2.50 per wagon; \$0.50 pushcart; \$0.50 can carried; \$1.00 store; \$5.00 each place.....	0	1	1	0	2
\$3.00 per wagon; \$1.00 each store; 1 to 5 cows, \$0.25; 6 to 10 cows, \$0.50; above 10 cows, \$1.00.....	0	1	0	0	1
\$5.00 per wagon; \$2.00 each additional wagon.....	1	0	0	0	1
\$5.00 per wagon; \$2.00 cart; \$1.00 carried...	0	0	1	0	1
\$10.00 each wagon; \$2.00 per dairy; \$10.00 each place of business.....	0	1	0	0	1
\$10.00 1st wagon; \$10.00 additional wagons; \$1.00 each cow 1-10 cows; \$5.00 less than 10 gal. milk.....	0	0	1	0	1
\$0.25 per cow.....	1	0	0	0	1
.50 per cow.....	1	0	0	0	1
.75 per cow.....	1	0	0	0	1
1.00 per cow.....	2	1	0	0	3
\$0.50 per cow; \$0.10 each additional cow.	1	0	0	0	1
\$1.00 per cow, 1-10 cows; \$0.50 per cow over 10.....	3	0	0	0	3
\$0.50 per cow, 1-5 cows; \$0.40 per cow, 6-10 cows; \$0.30 per cow, 11-20 cows; \$0.20 per cow, 21-50 cows; \$0.10 per cow, 51-100 cows; \$0.05 each cow above 100.....	0	1	0	0	1
\$0.50 1 cow; \$1.00 2 cows; \$1.50 3 cows; \$2.00 4 and above.....	1	0	0	0	1
\$0.50 per cow; \$2.00 place of business.....	0	1	0	0	1
\$1.00, 1-3 cows; \$0.50 each additional cow; \$10.00 for license.....	1	0	0	0	1
Selling 15,000 lbs. milk per month, \$1.00 per month; 15,000-40,000 lbs., \$2.00 per month; 40,000-80,000 lbs., \$4.00 per month; 80,000-160,000 lbs., \$8.00 per month; 160,000-240,000 lbs., \$12.00 per month; 240,000-320,000 lbs., \$15.00 per month; above 320,000 lbs., \$20.00 per month.....	0	1	0	0	1

Charges for permits or licenses—Concluded

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of cities which require inspection of plant and dairies before granting licenses.....	69	35	20	2	126
Number of cities requiring no inspection of dairies and plants.....	165	90	22	6	283
Number of cities specifying that a license be secured for each place of business.....	0	0	4	2	6
Number of cities not specifying this.....	234	125	38	6	403

CHEMICAL COMPOSITION

Legal limits for composition of milk and cream vary greatly. The regulations of about four-tenths of the cities specify legal limits for water content. Of those cities specifying a limit for water, we found the amount permitted to vary from 80 per cent to 89 per cent, one city having incorporated in its ordinance the following: "Milk shall not contain more than 80 per cent water." The majority of the cities permit a maximum water content of 88 per cent.

Less than one-half of the cities have a requirement for a minimum percentage of total solids. The amount of total solids required varies from 10.5 per cent to 13 per cent. Three-fifths of the cities have an established minimum of 12 per cent for total solids.

Approximately one-fourth of the cities have an established requirement for a minimum percentage of solids not fat. The required amount of solids not fat varies from 8 per cent to 10.5 per cent, with nearly six-sevenths of the cities having a minimum requirement of 8.5 per cent.

A requirement for a minimum percentage of fat in milk has been established by approximately five-eighths of the cities. The amount of fat required varies from 2.5 per cent to 4 per cent. Three-tenths of the cities require not less than 3 per cent fat, and one-tenth require not less than 3.25 per cent. Over half

of the cities have established as the legal minimum 3.5 per cent of fat or less. Practically the same number of cities which have established a minimum percentage for fat in milk have also established a minimum percentage for fat in cream. Approximately one-half of the cities require not less than 18 per cent fat. About one-eighth of the cities require not less than 20 per cent fat. One-eighth require 16 per cent fat, and one-eighth require 15 per cent fat. It will be observed that in the matter of chemical composition there is a very great variation in the requirements, and milk or cream that may be legally sold in one city may not be so sold elsewhere. The detailed information is as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations limiting percentage of water.....	79	53	21	7	160
Number of regulations not referring to percentage of water.....	155	72	21	1	249
Number of regulations limiting water content of milk to					
89.00 per cent.....	1	0	1	0	2
88.51 per cent.....	0	11	0	0	11
88.50 per cent.....	3	0	2	2	7
88.25 per cent.....	2	2	1	0	5
88.00 per cent.....	44	29	12	4	89
87.51 per cent.....	1	2	0	0	3
87.50 per cent.....	12	4	3	1	20
87.05 per cent.....	0	1	0	0	1
87.00 per cent.....	12	3	2	0	17
80.50 per cent.....	1	0	0	0	1
80.00 per cent.....	2	1	0	0	3
8.00 per cent.....	1	0	0	0	1

Total solids

Number of regulations requiring a minimum percentage of total solids.....	106	60	25	7	198
Number of regulations not referring to percentage of total solids.....	128	65	17	1	211

Total solids—Continued

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations having or calling for					
13.00 per cent total solids.....	13	2	2	0	17
12.51 per cent total solids.....	2	2	1	0	5
12.50 per cent total solids.....	15	1	3	1	20
12.15 per cent total solids.....	6	2	0	0	8
12.00 per cent total solids.....	59	46	15	4	124
11.75 per cent total solids.....	2	2	1	0	5
11.50 per cent total solids.....	7	5	3	2	17
11.00 per cent total solids.....	1	0	0	0	1
10.50 per cent total solids.....	1	0	0	0	1

Solids not fat

Number of regulations calling for minimum percentage of solids not fat.....	38	24	16	1	79
Number of regulations not referring to percentage of solids not fat.....	198	103	26	7	334
Number of regulations calling for					
10.50 per cent solids not fat.....	0	1	0	0	1
9.50 per cent solids not fat.....	1	1	0	0	2
9.25 per cent solids not fat.....	0	1	0	0	1
9.00 per cent solids not fat.....	6	2	1	0	9
8.75 per cent solids not fat.....	1	2	4	0	7
8.50 per cent solids not fat.....	28	14	11	1	54
8.25 per cent solids not fat.....	0	1	0	0	1
8.00 per cent solids not fat.....	2	2	0	0	4

Fat in milk

Number of regulations requiring a minimum percentage of fat.....	137	81	32	7	257
Number of regulations not referring to percentage of fat.....	97	44	10	1	152
Number of regulations calling for					
4.00 per cent fat.....	0	0	1	0	1
3.70 per cent fat.....	2	0	0	0	2
3.60 per cent fat.....	2	1	1	0	4
3.51 per cent fat.....	0	1	1	0	2
3.50 per cent fat.....	35	10	7	1	53
3.40 per cent fat.....	3	1	1	0	5
3.35 per cent fat.....	8	2	0	0	10

Fat in milk—Continued

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations calling for					
3.30 per cent fat.....	0	1	0	0	1
3.25 per cent fat.....	20	19	6	1	46
3.20 per cent fat.....	0	2	2	0	4
3.00 per cent fat.....	67	43	12	5	127
2.50 per cent fat.....	0	1	1	0	2

Fat in cream

Number of regulations requiring a minimum percentage of fat.....	87	49	20	5	161
Number of regulations not referring to percentage of fat.....	147	76	22	3	248
Number of regulations calling for					
25.0 per cent fat.....	3	1	0	0	4
22.0 per cent fat.....	1	0	0	0	1
20.0 per cent fat.....	13	3	5	0	21
19.0 per cent fat.....	1	0	0	0	1
18.0 per cent fat.....	42	29	12	2	85
17.5 per cent fat.....	1	0	0	0	1
16.0 per cent fat.....	10	6	3	0	19
15.0 per cent fat.....	13	10	0	3	26
14.0 per cent fat.....	2	0	0	0	2
10.0 per cent fat.....	1	0	0	0	1

Samples

Number of regulations in which the amount of the sample to be taken was stated.....	15	8	9	0	32
Number of regulations in which the amount of sample to be taken was not stated.....	229	117	33	8	387
Number of regulations calling for quart samples.	11	1	7	0	19
1 pint.....	3	4	2	0	9
$\frac{1}{2}$ pint.....	0	2	0	0	2
$\frac{1}{4}$ pint.....	1	1	0	0	2

BACTERIA

Less than one-half the cities have regulations relating to the number of bacteria in milk. The requirements of cities providing a numerical limit for bacteria in milk range from a permitted maximum of 50,000 bacteria per cubic centimeter to a permitted maximum of 5,000,000 bacteria per cubic centimeter. Approximately one-half of these cities have established a numerical limit of 500,000 bacteria per cubic centimeter as the greatest number that may be legally contained in milk that is offered for sale. About one-sixth of the cities have established a legal numerical limit of between 250,000 and 300,000 bacteria per cubic centimeter. One-sixth of the cities forbid the sale of milk having over 100,000 bacteria per cubic centimeter.

About one-eleventh of the cities have established bacterial limits for cream, and the number of organisms legally permitted in one cubic centimeter varies from 50,000 to 1,000,000. One-third of these cities specify 500,000 as the legal maximum number, one-third 1,000,000 as the legal maximum number, and the others, with one exception, require somewhat less than 500,000 bacteria per cubic centimeter in cream. The detailed information is as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations having a legal limit for bacteria in milk.....	95	66	24	4	189
Number of regulations not referring to bacterial limits.....	139	59	18	4	220
Number of regulations having a numerical limit for bacteria of.....					
50,000 per cubic centimeter.....	1	1	0	0	2
100,000 per cubic centimeter.....	21	11	3	0	35
150,000 per cubic centimeter.....	1	3	1	0	5
200,000 per cubic centimeter.....	6	7	4	0	17
250,000 per cubic centimeter.....	7	4	2	0	13
300,000 per cubic centimeter.....	7	10	2	0	19
350,000 per cubic centimeter.....	0	0	0	0	0

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations having a numerical limit for bacteria of:					
400,000 per cubic centimeter.....	1	1	1	0	3
>500,000 per cubic centimeter.....	49	27	11	2	89
1,000,000 per cubic centimeter.....	2	2	0	1	5
5,000,000 per cubic centimeter.....	0	0	0	1	1
Number of regulations having a legal limit for bacteria in cream.....	7	15	8	0	30
Number of regulations not referring to bacterial limits in cream.....	227	110	34	8	379
Number of regulations having a numerical limit for bacteria of:					
50,000 per cubic centimeter.....	1	0	0	0	1
100,000 per cubic centimeter.....	0	1	0	0	1
150,000 per cubic centimeter.....	0	1	0	0	1
200,000 per cubic centimeter.....	1	1	0	0	2
250,000 per cubic centimeter.....	0	0	0	0	0
300,000 per cubic centimeter.....	0	1	2	0	3
350,000 per cubic centimeter.....	0	1	0	0	1
>500,000 per cubic centimeter.....	1	4	5	0	10
800,000 per cubic centimeter.....	1	0	0	0	1
>1,000,000 per cubic centimeter.....	3	6	1	0	10

TEMPERATURE

Approximately five-eighths of the cities have established maximum temperature limits for milk. About one-half of these cities have fixed 50° F. as the highest legal temperature for milk at the farm; nearly one-third of these cities have fixed 60° F. as the highest legal temperature for milk at the farm. A few permit temperatures as high as 70° F., while others require temperatures not higher than 45° F. In about one-half the cities regulations fixing the maximum temperatures permitted for milk on common carriers have been provided. About one-half of these have prohibited a temperature higher than 50° F., and about one-fourth prohibit a temperature higher than 60° F. Other cities require temperatures not higher than 45° F., and some permit temperatures as high as 77° F. The temperatures of milk re-

quired at time of delivery are essentially the same as those required under transportation. The detailed information is as follows:

Temperature

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations having a legal temperature limit for milk at farm.....	131	86	30	4	251
Number of regulations not having a legal temperature limit for milk at farm.....	103	39	12	4	158
Number of regulations calling for a temperature not higher than					
77° F.....	1	0	0	0	1
70° F.....	2	1	1	0	4
65° F.....	4	3	2	0	9
60° F.....	42	19	8	1	70
58° F.....	2	3	1	0	6
55° F.....	11	14	1	1	27
50° F.....	67	45	16	1	129
45° F.....	2	1	1	1	5
Number of regulations prescribing temperature for milk on common carriers.....	95	75	27	4	201
Number of regulations not prescribing temperature for milk on common carriers.....	139	50	15	4	208
Number of regulations calling for a temperature not higher than					
77° F.....	1	0	0	0	1
70° F.....	1	2	2	0	5
65° F.....	6	1	1	0	8
63° F.....	0	2	0	0	2
60° F.....	26	21	10	1	58
58° F.....	0	1	0	0	1
55° F.....	11	12	1	1	25
50° F.....	49	36	13	2	100
45° F.....	1	0	0	0	1
Number of regulations prescribing for milk in city temperature.....	95	74	32	7	208
Number of regulations not prescribing or stating temperature of milk in city.....	139	51	10	1	201
Number of regulations calling for a temperature not higher than					
77° F.....	1	0	0	0	1
70° F.....	1	2	2	0	5

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations calling for a temperature not higher than					
65° F.....	6	1	2	0	9
63° F.....	0	2	0	0	2
60° F.....	27	19	11	1	58
58° F.....	0	1	0	0	1
56° F.....	1	0	0	0	1
55° F.....	12	13	2	0	27
50° F.....	46	36	15	5	102
45° F.....	1	0	0	1	2

SPECIFIC GRAVITY

Only 38 cities have established a minimum for specific gravity of milk. Of these, 25 state 1.029 as the minimum. The requirements of the other cities range from 1.027 to 1.033. (The regulation of one city calls for milk of a specific gravity of 10.29, another requires a specific gravity of 1030.0, and another a specific gravity of 1029.0!)

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations prescribing a minimum specific gravity.....	0	31	7	0	38
Number of regulations requiring a specific gravity of					
1030.0.....	0	2	0	0	2
*1029.0.....	0	4	0	0	4
10.29.....	0	2	0	0	2
1.030.....	0	1	1	0	2
1.029-1.033.....	0	0	3	0	3
1.029.....	0	20	3	0	23
1.028.....	0	1	0	0	1
1.027.....	0	1	0	0	1

CONDITIONS WHICH RENDER MILK UNSALABLE

Three hundred and ninety-six cities forbid the sale of milk produced or handled under certain stated conditions.

Two hundred and eighty-seven declare milk unsalable when cows are diseased; 115 when cows are kept in filthy quarters; 82 when the milk contains visible dirt; 144 when cows are kept in crowded and unhealthy stables; 260 when milk is adulterated; 205 when milk contains foreign substance. There are in all about 58 conditions which render milk legally unsalable and which are included in one or more city ordinances. Some of the prohibited foods for milch cows are as follows: Swill, distillers' grains, garbage, vinegar waste, turnips, cabbage, garlic; and one prohibits feeding the cows on silage. Another regulation states: "No person shall sell, deliver, etc., 'Milk drawn from cows fed in whole or in part on green corn or silage, unless the person so selling or delivering shall first inform the person to whom it is sold or delivered of the nature of the milk so sold or delivered.'" Another regulation states: "No milk shall be sold from cows fed corn stalks before the corn has blossomed." And still another regulation provides that "Milk is unsalable when produced in stables containing cattle or other animals."

The conditions in detail which render milk legally unsalable in these cities are as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations which forbid the sale of milk under conditions stated below.....	234	115	39	8	396
Number of regulations which do not mention when milk is unsalable.....	0	10	3	0	13
Number of regulations which mention					
Diseased cows.....	160	85	34	8	287
Cows kept in filthy quarters.....	67	36	12	0	115
Milk containing visible dirt.....	46	29	6	1	82
Cows kept in crowded and unhealthy stable.....	79	43	20	2	144

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations which mention					
Milk when adulterated.....	150	77	30	3	260
When cows are fed distillers' grains.....	59	42	17	7	125
When cows are fed swill.....	58	41	14	3	116
From cows a certain number of days before calving.....	139	86	27	6	258
From cows a certain number of days after calving.....	138	89	27	6	260
Foreign substance in milk.....	107	65	28	5	205
Putrefactive feeds.....	57	38	21	4	120
Feeds unwholesome.....	73	50	22	0	145
Feeds impure.....	47	38	10	0	95
Milk unclean.....	23	16	5	0	44
Cows fed on refuse.....	41	28	9	2	80
Cows fed garbage.....	34	34	13	3	84
Cows fed wet brewers' grains.....	32	22	12	2	68
Cows given contaminated water.....	19	10	18	3	50
Cows fed vinegar waste.....	6	6	6	0	18
Pus in milk.....	8	4	1	0	13
Cows fed beet pulp.....	5	1	0	0	6
Cows fed turnips.....	2	2	0	0	4
Cows fed starch waste.....	8	4	0	0	12
Diseased cows.....	1	2	0	0	3
Insanitary foods.....	1	0	0	0	1
Frozen foods.....	1	0	0	0	1
Ropy milk.....	8	6	0	0	14
Bloody milk.....	14	11	4	1	30
Milk above legal limits in bacteria.....	94	18	0	0	112
Milk above legal limits in temperature.....	139	44	2	0	185
Improper milk.....	2	4	3	0	9
Watered.....	1	0	0	0	1
Diluted.....	3	0	0	0	3
Silage.....	1	1	0	0	2
Unsound.....	1	0	0	0	1
Tainted.....	1	1	1	0	3
Musty.....	1	0	0	0	1
Insects.....	1	0	0	0	1
Hairs.....	1	0	0	0	1
Flies.....	1	0	0	0	1

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations which mention					
Sediment.....	1	0	1	0	2
Sour.....	1	0	0	0	1
Sophisticated.....	1	0	0	0	1
Mouldy.....	1	2	0	0	3
Decayed.....	3	0	0	0	3
Acid plus 2.....	1	6	1	0	8
Garget.....	1	0	0	0	1
Abnormal.....	3	0	0	0	3
Unnatural.....	0	1	2	0	3
Bitter.....	0	1	0	0	1
Decomposed.....	0	1	0	0	1
Glucose.....	0	3	0	0	3
Garlic.....	0	1	0	0	1
Unhealthy.....	0	9	4	0	13
Stringy.....	0	2	2	0	4
Cabbage.....	0	2	0	0	2
Slimy.....	0	0	2	1	3
Sugar waste.....	0	0	1	0	1

PARTURITION

The regulations in regard to parturition vary greatly. Four cities prohibit the sale of milk 60 days before parturition, and one city permits the sale of milk up to 4 days before parturition. One city prohibits the sale of milk sooner than 21 days after parturition, and one city permits the sale of milk as soon as 3 days after. 235 of the 261 cities having regulations on this subject prohibit the sale of milk from 15 to 30 days before parturition, and 244 of the 261 cities prohibit the sale of milk from 5 to 12 days after parturition. Detailed information is as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations providing for a specific number of days before and after parturition that the milk cannot be used.....	139	89	27	6	261
Number of regulations which do not cover this point.....	95	36	15	2	148
Number of regulations prohibiting the sale of milk					
60 days before parturition.....	4	0	0	0	4
45 days before parturition.....	1	0	0	0	1
42 days before parturition.....	0	1	0	0	1
40 days before parturition.....	0	1	0	0	1
30 days before parturition.....	19	3	1	0	23
21 days before parturition.....	6	5	0	0	11
20 days before parturition.....	11	7	3	0	21
15 days before parturition.....	89	63	23	5	180
14 days before parturition.....	4	1	0	0	5
12 days before parturition.....	0	1	0	0	1
10 days before parturition.....	1	2	0	1	4
8 days before parturition.....	4	1	0	0	5
4 days before parturition.....	0	1	0	0	1
Number of regulations prohibiting the sale of milk					
21 days after parturition.....	1	0	0	0	1
15 days after parturition.....	5	3	1	0	9
12 days after parturition.....	7	7	3	0	17
10 days after parturition.....	28	12	5	1	46
9 days after parturition.....	3	2	0	0	5
8 days after parturition.....	4	0	1	0	5
7 days after parturition.....	10	8	2	1	21
6 days after parturition.....	4	3	2	1	10
5 days after parturition.....	72	52	13	3	140
4 days after parturition.....	3	2	0	0	5
3 days after parturition.....	1	0	0	0	1

TUBERCULIN TESTING OF COWS

Ninety-eight cities require the tuberculin testing of cows, and 50 of these 98 cities require the cows to be tuberculin tested yearly. Three cities require cows to be tuberculin tested once in

two years. One city requires cows to be tuberculin tested twice a year, and one city requires that cows be tuberculin tested at the discretion of the inspector.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations specifying that cows					
Be tuberculin tested.....	53	21	21	3	98
Be tested once a year.....	20	16	14	0	50
Be tested once in two years.....	2	1	0	0	3
Be tested twice a year.....	0	1	0	0	1
Be tested at discretion of inspector.....	0	0	1	0	1

CLEANLINESS OF COWS

Eighty-four cities require that udders be washed before milking. 81 cities require that the udders be wiped with a damp cloth before milking, and 147 cities simply require that the udders be clean. 33 cities require that hair be clipped from the udders.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations specifying that					
Udders be washed before milking.....	51	23	10	0	84
Udders be wiped with damp cloth before milking.....	48	25	8	0	81
Udders be cleaned with dry cloth.....	17	4	2	0	23
Hairs on udders be clipped.....	17	13	2	1	33
Manure be removed from body of cow...	30	15	7	3	55
Udders be clean.....	70	53	20	4	147

STABLES

Two hundred and three cities specify that stables must be clean; 49 require that clean bedding be provided; 173 require that stables be well ventilated, 165 that stables be well lighted, and

only 33 specify the amount of window space to be provided per cow. The glass so required varies from 2 to 6 square feet. 10 cities favored 3 square feet and 12 cities 4 square feet window space for the space occupied by one cow. 86 cities specify the minimum air space per cow. The required space varies from 100 cubic feet per cow to 1,000 cubic feet per cow. Eighty per cent of the cities require 500 cubic feet or more. 52 cities require 500 cubic feet. One city requires $1\frac{1}{2}$ cubic feet of air space for every pound of live weight of the cow.

One hundred and seventeen cities require that stables be free from manure. 119 cities require tight, sound stable floors. 134 cities require stable floors to be well drained. Only 51 cities require tight, clean ceilings. The regulations of 138 cities require the removal of manure from the stable, but 40 of these regulations do not specify how often manure shall be removed. Of 96 cities which require the manure removed each day, 50 require it removed once daily and 46 twice daily. 42 cities specify the distance from the stable to which the manure shall be removed. The distance varies from 10 feet to 300 feet, but most requirements specify a distance of from 30 to 50 feet.

One hundred and thirty-two cities specify that whitewashing of the stable is necessary. Some cities require it once in three months, and others once in two years. Approximately one-third of the cities require the stables to be whitewashed every year, and another one-third, every six months. The detailed information follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring					
That stable be clean.....	118	63	19	3	203
That clean bedding be provided.....	26	14	8	1	49
That stable be well ventilated.....	86	64	21	2	173
That stable be well lighted.....	88	54	20	3	165

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring					
2 square feet of glass per cow.....	6	2	1	0	9
3 square feet of glass per cow.....	4	4	1	1	10
4 square feet of glass per cow.....	6	2	4	0	12
6 square feet of glass per cow.....	1	0	0	1	2
Number of regulations in which glass area is not mentioned.....	71	46	13	2	132
Number of regulations requiring that					
Stable be free from cobwebs.....	29	17	6	0	52
Stable be free from dust.....	40	20	7	0	67
Stable be free from manure.....	63	44	9	1	117
Stable have tight sound floors.....	64	36	16	3	119
Floors be well drained.....	71	39	21	3	134
Walls be tight and clean.....	14	15	2	3	34
Ceilings be tight and clean.....	24	17	7	3	51
Number of regulations requiring "proper" air space.....	54	32	19	1	106
Number of regulations in which amount of air space is not specified.....	9	7	23	0	39
Number of regulations requiring					
1,000 cubic feet space per cow.....	2	1	1	0	4
600 cubic feet space per cow.....	4	6	3	0	13
500 cubic feet space per cow.....	30	11	11	0	52
400 cubic foot space per cow.....	3	6	2	0	11
350 cubic feet space per cow.....	1	1	0	0	2
300 cubic feet space per cow.....	2	0	0	0	2
100 cubic feet space per cow.....	1	0	0	0	1
demanding proper air space but no amount specified.....	0	0	2	0	2
1½ cubic feet air space for every pound of live weight.....	0	0	0	1	1
Number of regulations requiring the white- washing of stable.....	74	38	17	3	132
Number of regulations in which the time be- tween whitewashings is not specified.....	16	7	9	2	34
Number of regulations requiring whitewashing of stable					
Every 2 years.....	1	5	0	0	6
Every year.....	27	14	1	0	42
Every 6 months.....	29	12	6	1	48
Every 3 months.....	1	0	0	0	1
Frequently.....	0	0	1	0	1
Number of regulations requiring that no other animals should be allowed in the stable.....	71	37	14	2	124

Removal of manure from stables

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring the removal of manure.....	70	48	17	3	138
Number of regulations not stating how often manure must be removed.....	16	18	5	1	40
Number of regulations requiring removal of manure once daily.....	26	21	3	0	50
Twice daily.....	28	8	8	2	46
Weekly.....	0	1	0	0	1
Frequently.....	0	0	1	0	1
Number of regulations requiring manure to be removed					
300 feet.....	0	2	1	0	3
200 feet.....	0	1	1	0	2
100 feet.....	1	3	0	0	4
75 feet.....	0	0	1	0	1
60 feet.....	0	2	0	0	2
50 feet.....	2	4	4	0	10
40 feet.....	1	4	0	0	5
30 feet.....	4	7	1	0	12
10 feet.....	1	1	0	0	2
Away.....	0	0	1	0	1

STABLE YARDS

With reference to the barnyard, 93 cities require them to be clean, 66 require them to be well drained, 74 require them to be free from manure piles, and 50 require them to be free from stagnant water.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring barnyard to be					
Clean.....	45	40	8	0	93
Well drained.....	30	21	13	2	66
Free from manure piles.....	29	31	12	2	74
Free from stagnant water.....	21	20	8	1	50

WATER SUPPLY

Regarding the water supply for the dairy farms, 107 cities require that it be clean, 30 cities that it be fresh, 12 cities that it be convenient, 53 cities that it be abundant, 98 cities that it be free from contamination, and 14 cities that it be pure. The information in detail is as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that water supply be					
Clean.....	70	26	11	0	107
Fresh.....	23	3	4	0	30
Convenient.....	7	0	4	1	12
Abundant.....	29	14	9	1	53
Free from contamination.....	54	30	12	2	98
Pure.....	0	6	8	0	14
Well chosen.....	0	1	0	0	1
Suitable.....	0	1	0	0	1

MILKERS

The regulations of 190 cities require that milkers be free from disease. 131 cities require that they be clean. 108 cities require that they wear clean clothes, and 111 cities require that they wash their hands before milking. Seventy-nine cities require the milking to be done with clean dry hands.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that					
Milker be free from disease.....	109	54	22	5	190
Milker be clean.....	78	40	13	0	131
Milker wear clean clothes.....	61	34	12	1	108
Milker wash hands before milking.....	52	41	16	2	111
Milker brush nails before milking.....	8	4	2	0	14
Milking be done with clean dry hands....	46	22	10	1	79
Hands be not wet during milking.....	12	22	4	0	38

MILK HOUSE

Most cities requiring milk houses specify that they be located apart from stables or privies. The shortest distance from stable permitted varies from 10 to 100 feet. The average distance is 34 feet. The shortest distance from a privy at which a milk house can be legally located varies from 10 to 300 feet. The average distance is 90 feet.

Proper ventilation, lighting, screening, tight sound floors and good drainage are by far most frequently mentioned in the requirements regarding construction of milk houses. 150 cities require that milk houses be used only for the handling of milk, and 232 cities require that milk houses be kept clean.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that milk houses be					
Clean.....	132	75	22	3	232
Used for no other purpose.....	82	46	19	3	150
Have tight sound floor.....	46	27	13	1	87
Be well ventilated.....	62	27	11	1	101
Be well lighted.....	51	24	11	1	87
Be well drained.....	36	20	14	1	71
Number of regulations requiring sterilizing equipment in the milk house	13	16	2	0	31
Number of regulations requiring that milk house be					
Well screened.....	63	44	16	2	125
Provided with suitable racks.....	5	4	6	0	15
Provided with cooling tanks.....	8	12	5	1	26
Located a certain distance from the stable	45	15	11	0	71
Number of regulations requiring milk house to be located					
100 feet from stable.....	3	2	0	0	5
50 feet from stable.....	4	0	1	0	5
40 feet from stable.....	1	0	0	0	1
25 feet from stable.....	1	0	1	0	2
20 feet from stable.....	1	0	0	0	1
15 feet from stable.....	1	0	0	0	1
12 feet from stable.....	0	0	1	0	1

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring milk house to be located					
10 feet from stable.....	1	0	1	0	2
Away from stable.....	28	10	2	0	40
At a distance from stable.....	2	0	0	0	2
With an air space between milk house and stable.....	1	0	0	0	1
Apart.....	1	3	0	0	4
Distance not given.....	1	1	5	0	7
Number of regulations requiring that					
Milk house be free from odors.....	52	22	6	0	80
No swine be within a stated distance....	27	7	0	1	35
No swine be within 100 feet.....	1	0	0	0	1
No swine be within 50 feet.....	26	0	0	0	26
Swine be "not near".....	0	0	1	0	1
Number of regulations requiring that milk house					
Be a separate room.....	74	48	26	3	151
Be a distance from privy.....	56	40	13	1	110
300 feet from privy.....	0	1	0	0	1
200 feet from privy.....	1	0	0	0	1
100 feet from privy.....	2	3	1	0	6
75 feet from privy.....	0	0	1	0	1
50 feet from privy.....	4	1	1	1	7
40 feet from privy.....	2	0	0	0	2
25 feet from privy.....	2	3	0	0	5
15 feet from privy.....	2	3	0	0	5
10 feet from privy.....	0	0	1	0	1
Away from privy.....	16	18	0	0	34
Not near privy.....	6	1	0	0	7
Distant.....	21	0	0	0	21
Not mentioned.....	0	10	9	0	19

MILK UTENSILS

Fifty-eight cities require utensils of non-absorbent material. 30 cities require that dairy utensils have round or smooth joints. 62 cities require that dairy utensils be "well constructed." Only about 15 per cent of the cities fail to prescribe the use of clean utensils. The regulations of 206 cities specify that dairy utensils be clean. 165 cities specify that they be washed, 93

cities specify that utensils be scalded, and 226 specify that dairy utensils be sterilized. 109 cities require that dairy utensils be used for no other purpose, and 120 cities require their protection from contamination.

Construction of utensils

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that only round cornered utensils be used.....	6	5	0	0	11
Number of regulations requiring that only utensils with smooth joints be used.....	5	4	7	3	19
Number of regulations requiring that utensils be made of non-absorbent material.....	36	15	7	0	58
Number of regulations requiring that utensils be well constructed.....	30	17	14	1	62

Cleaning of utensils

Number of regulations requiring that utensils be					
Clean.....	112	71	22	1	206
Washed.....	94	52	17	2	165
Scalded.....	48	28	14	3	93
Sterilized.....	121	73	25	7	226
Used for no other purpose.....	56	33	17	3	109
Protected from contamination.....	52	51	16	1	120
Number of regulations represented in the above items.....	184	114	37	7	342
Number of regulations containing nothing regarding the cleaning of utensils.....	50	11	5	1	67

Milk straining

Number of regulations requiring milk to be strained in milk house only.....	38	31	5	0	74
Number of regulations requiring milk to be strained					
Outside the barn.....	3	2	3	0	8
Immediately.....	44	38	12	0	94
Through cotton.....	6	4	1	0	11
Through flannel.....	6	2	0	0	8
Through cheese cloth.....	5	11	3	0	19
Through wire.....	5	7	1	0	13

The milk

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that					
Milk be removed immediately from barn...	89	45	17	3	154
Milk be cooled immediately.....	89	61	18	3	171
Milk be aerated.....	23	11	6	0	40
Fore milk be discarded.....	4	6	6	1	17
Milk must not be strained in barn.....	4	4	2	1	11
Milk must be stored only in milk house....	9	33	6	0	48
Milk be milked into covered pails.....	20	14	8	2	44
Milk be graded.....	0	5	4	0	9

THE SCORING OF DAIRY FARMS

The dairy farm score card system of inspection is required by 56 cities. The score card developed by this association and generally introduced by the U. S. Department of Agriculture is almost universally used in the 56 cities. It is interesting also in this connection to note that the score card system is used by 184 other cities that do not have regulations requiring its use. 56 cities require a minimum score as follows:

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Minimum score of dairy farms					
80.....	2	1	0	0	3
75.....	1	0	0	0	1
65.....	2	0	1	1	4
60.....	8	12	3	0	23
55.....	0	2	1	1	4
50.....	3	1	0	0	4
46.....	0	0	1	0	1
45.....	3	2	0	0	5
40.....	6	4	0	0	10
Not given.....	1	0	0	0	1

CITY MILK PLANTS

The principal requirements call for proper lighting, ventilation, screens, tight floors, drains, and proper equipment. Each of these conditions is included in about one-third of the regulations. 70 cities specify that city milk plants must be clean. 10 cities specify that such plants be free from flies, and 15 cities require facilities for cleaning utensils in plant. 13 cities have adopted the score card system of milk plant inspection, and require scores of from 40 to 75 points. A score of 70 points is required in 5 cities.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that milk plant shall					
Be well lighted.....	9	8	7	2	26
Be well ventilated.....	6	7	6	2	21
Be well screened.....	10	18	6	1	35
Be well drained.....	7	8	6	2	23
Be properly constructed.....	2	7	5	2	16
Be properly equipped.....	8	6	8	0	22
Be clean.....	19	27	19	5	70
Be free from flies.....	5	1	2	2	10
Be free from odors.....	4	1	2	1	8
Be free from contamination.....	2	3	1	2	8
Have sewer connections.....	2	3	2	0	7
Have facilities for cleaning utensils in plant.....	2	5	5	3	15
Have facilities for storing milk in plant....	3	2	0	2	7
Have running hot and cold water.....	2	5	1	1	9
Have separate room for handling milk...	4	2	5	1	12
Have tight walls and ceilings.....	2	5	6	1	14
Have tight floors.....	9	7	7	2	25
Score a certain number of points.....	5	5	3	0	13
Shall score not less than					
40 points.....	0	1	0	0	1
50 points.....	1	1	0	0	2
60 points.....	0	1	1	0	2
70 points.....	2	2	1	0	5
75 points.....	0	0	1	0	1
not mentioned.....	2	0	0	0	2

DELIVERY WAGONS

Two hundred and seventeen cities require the name of the dealer on delivery wagons. 232 cities specify that the number of dealer's license must appear on wagon. 158 cities require clean wagons and 85 require covered wagons. In 177 cities the drivers are required to be free from disease.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring					
Drivers to be free from disease.....	110	53	14	0	177
Wagons to be covered.....	42	30	12	1	85
Wagons to be clean.....	88	52	15	3	158
Wagons not to haul refuse or be used for any other purpose.....	61	41	14	0	116
Name of dealer to appear on wagon.....	112	78	23	4	217
Number of license to appear on wagon...	123	74	29	6	232

LABELING AND SALE

Seventy-seven cities require milk to be sold in bottles only on the street, and 80 cities specify that milk be sold only in bottles in stores. Other cities permit sale from cans; 224 cities require skimmed milk to be labeled as such; and 132 cities specify the heights of the letters. 81 cities require such letters to be one inch high, and 46 cities require the letters to be at least $1\frac{1}{2}$ inches or higher.

Only 93 cities specify that milk tickets shall be used only once. 316 cities fail to state how milk tickets, if used, shall be used. 42 cities require the name of the dealer to appear on bottle caps. 24 require the license number to be printed on caps. 18 require the date of bottling printed on caps. 27 require the grade of milk to be indicated on caps. 30 state that bottle caps must be clean. 19 cities require the name of the dealer to be blown into the glass in making bottles. 179 cities permit bottles to be filled with milk only at the plant.

71 cities require bottles to be cleansed by consumers immediately after emptying.

Forty-four cities require that pasteurized milk be labeled as such; and 67 cities specify the temperatures to which milk shall be heated and time milk shall be held when pasteurized.

Store milk

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring					
Milk to be sold in bottles only.....	45	20	13	2	80
Bottles to be covered in store.....	31	10	12	3	56
Refrigerator to be clean.....	0	0	0	3	3

Milk tickets

Number of regulations requiring that milk tickets be used but once.....	49	34	9	1	93
Number of regulations not limiting the use of tickets.....	185	91	33	7	316

Skimmed milk

Number of regulations requiring cans and bottles to be marked.....	116	74	29	5	224
Number of regulations prescribing heights of letters.....	66	42	21	3	132
Number of regulations requiring letters					
4 inches high.....	2	1	0	0	3
3 inches high.....	8	10	4	0	22
2 inches high.....	5	7	4	0	16
1½ inches high.....	4	1	0	0	5
1 inch high.....	44	21	13	3	81
½ inch high.....	3	0	0	0	3
⅝ inch high.....	0	2	0	0	2

Milk bottles

Number of regulations requiring that bottles be sealed before using.....	25	12	15	1	53
Number of regulations requiring that					
Name of dealer appear in the glass.....	9	6	4	0	19
Bottles be filled at plant only.....	76	72	28	3	179
Bottles be cleansed immediately after emptying by consumer.....	27	29	12	3	71

REPORT OF COMMITTEE

Bottle caps

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regulations requiring that name of dealer be printed on bottle caps.....	16	15	9	2	42
Number of regulations requiring that license number of dealer be printed on bottle caps.....	15	7	2	0	24
Number of regulations requiring that date of bottling be printed on bottle caps.....	7	6	5	0	18
Number of regulations requiring that grade of milk be printed on bottle caps.....	14	10	3	0	27
Number of regulations requiring that bottle caps be clean.....	10	14	3	3	30

Street milk

Number of regulations requiring milk to be sold in bottles only.....	45	22	10	0	77
Number of regulations requiring that bottles be covered.....	30	10	10	0	50

Pasteurized milk

Number of regulations requiring that pasteurized milk be labeled.....	17	16	6	5	44
Number of regulations requiring that in pasteurizing milk be heated and held for a certain time and at a given temperature.....	27	22	13	5	67

PENALTIES

In providing penalties for the violation of rules and regulations, 241 cities provide for either jail sentences or fines, or both. The fines vary from \$1.00 to \$1,000 and the jail sentences from three days to six months. One hundred and sixty-eight cities do not provide for penalties.

	POPULATION				TOTAL CITIES
	5,000 to 25,000	25,000 to 100,000	100,000 to 500,000	Over 500,000	
Number of regu- lations pre- scribing fines or penalties	125	75	36	5	241
Number of regu- lations not prescribing penalties.....	109	50	6	3	168
Fines in the regulations studied varied from.....	\$1 to \$500	\$5 to \$500	\$1 to \$1,000	\$5 to \$200	\$1 to \$1,000
Jail sentences...	3 days to 6 months	10 days to 6 months	5 days to 6 months	60 days	3 days to 6 months

Two hundred and twenty-three cities with populations between 5,000 and 100,000 report they have no regulations of any kind governing the sale of milk or cream.

One health officer, apologizing for his inability to send a copy of his city ordinance, stated: "Our city council is ossified and waits on the tail of progress."

Another says: "We have no regulations regarding the sale of milk and cream, and I am unable to get the city council to do anything in the matter."

Your committee on Statistics of Milk and Cream Regulations has also prepared in tabulated form the principal facts found in the laws and regulations of 29 states in so far as they pertain to the production, handling and sale of milk and cream. This tabulated summary is included as a part of this report, and is as follows:

SURVEY OF MILK AND CREAM REGULATIONS OF STATES

Number of states represented in this survey (including Philippine Islands)....	29
Number of complete regulations of states studied.....	29
Number of states not reporting milk and cream regulations.....	20

Milk licenses

Number of states requiring licenses or permits for the sale of milk.....	11
Number failing to mention or not requiring a license.....	18
Number of regulations which state that license is issued annually.....	9
Number of regulations which fail to state how often license is issued.....	20

Licenses and fees

Number of states requiring fees.....	8
Number of states not requiring fees.....	21
Number of states charging	
\$0.50 annually.....	1
1.00 annually.....	2
2.00 annually.....	1
1.00 each wagon.....	1
1.00 each wagon and store.....	2
1.00 each wagon, store and depot.....	1
Number of states requiring license or permit for each place of business.....	4
Number of states not requiring such permits.....	25
Number of states requiring inspection of distributing plant and dairies before granting licenses.....	2
Number of states not requiring such inspection.....	27

Chemical requirements.

Number of regulations limiting percentage of water.....	7
Number of regulations not regulating or stating percentage of water permitted.....	22
Number of regulations limiting percentage of water to	
\$9.00 per cent.....	1
\$8.50 per cent.....	1
\$8.25 per cent.....	1
\$8.00 per cent.....	1
\$7.51 per cent.....	1
\$7.05 per cent.....	1
\$7.00 per cent.....	1
Number of regulations establishing legal minimum for total solids.....	12
Number of regulations not having or not stating a legal minimum for total solids.....	17
Number of regulations requiring a legal minimum for total solids of	
13.00 per cent.....	1
12.51 per cent.....	1
12.50 per cent.....	1
12.15 per cent.....	1
12.00 per cent.....	5
11.75 per cent.....	2
11.50 per cent.....	1
Number of regulations establishing a legal minimum for solids not fat.....	15

Number of regulations not having or stating a legal minimum for solids not fat.....	14
Number of regulations requiring a legal minimum for solids not fat of	
9.25 per cent.....	1
8.75 per cent.....	2
8.50 per cent.....	11
8.00 per cent.....	1
Number of regulations establishing a legal minimum for fat.....	25
Number of regulations not having or stating a legal minimum for fat.....	4
Number of regulations requiring a legal minimum for fat of	
3.50 per cent.....	3
3.35 per cent.....	1
3.25 per cent.....	11
3.20 per cent.....	2
3.00 per cent.....	8
Number of regulations establishing a legal minimum for fat in cream.....	22
Number of regulations not having a legal minimum for fat in cream.....	7
Number of regulations requiring a legal minimum for fat in cream of	
20.0 per cent.....	1
18.0 per cent.....	17
16.0 per cent.....	3
15.0 per cent.....	1
Number of regulations in which the size of the sample to be taken was stated..	1
Number of regulations calling for 8 oz. sample.....	1

Bacterial limits

Number of regulations establishing a numerical limit for bacteria in milk....	4
Number of regulations not having or stating a numerical limit for bacteria in milk.....	25
Number of regulations limiting the number of bacteria per cubic centimeter to	
200,000.....	1
500,000.....	2
1,000,000.....	1
Number of regulations establishing a numerical limit for bacteria in cream...	2
Number of regulations not having or stating a numerical limit for bacteria in cream.....	27
Number of regulations limiting the number of bacteria per cubic centimeter in cream to	
200,000.....	1
500,000.....	1

Temperature requirements

Number of regulations requiring a certain temperature for milk on farm....	2
Number of regulations not having or requiring a certain temperature for milk on farm.....	27
Number of regulations calling for a temperature not higher than	
60°F.....	1
58°F.....	1

Number of regulations requiring a certain temperature for milk on common carriers.....	3
Number of regulations not having or requiring a certain temperature for milk on common carriers.....	26
Number of regulations calling for a temperature not higher than	
70° F.....	1
60° F.....	1
55° F.....	1
Number of regulations requiring a certain temperature for milk in city.....	3
Number of regulations not having or requiring a certain temperature for milk in city.....	26
Number of regulations calling for a temperature not higher than	
70° F.....	1
60° F.....	1
55° F.....	1
Number of regulations establishing a legal minimum specific gravity for milk.....	3
Number of regulations requiring a legal specific gravity of	
1.029-1.033.....	2
1.029	1
Number of regulations which forbid the sale of milk under stated conditions	29
Number of regulations which do not mention when milk is unsalable.....	0
Number of regulations which mention milk from diseased cows.....	24
From cows kept in filthy quarters.....	15
Containing visible dirt.....	3
From cows kept in crowded and unhealthy stables.....	16
When adulterated.....	21
From cows fed distillers' grains.....	11
From cows fed swill.....	2
From cows a certain number of days before calving.....	21
From cows a certain number of days after calving.....	21
Containing foreign substance.....	22
From cows eating putrefactive feeds.....	14
From cows when feed is unwholesome.....	14
From cows when feeds are impure.....	9
From cows when fed on refuse.....	3
From cows when fed glucose.....	2
From cows when fed garbage.....	4
From cows when fed wet brewers' grains.....	7
From cows drinking contaminated water.....	12
From cows when fed vinegar waste.....	2
From cows when fed starch waste.....	2
From cows when fed sugar waste.....	2
That is diseased.....	1
That is bloody.....	1
That is tainted.....	1
That is unclean.....	8
That is unnatural.....	1

STATISTICS OF MILK AND CREAM REGULATIONS

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That is decomposed.....	2
That is unhealthy.....	8
That is stringy.....	2
Total number of conditions and feeds which render milk unsalable.....	29

Parturition

Number of regulations which state a specific number of days before and after parturition during which milk cannot be sold.....	21
Number of regulations which do not cover this point.....	8
Number of regulations prohibiting the sale of milk	
30 days before parturition.....	1
15 days before parturition.....	15
14 days before parturition.....	2
10 days before parturition.....	2
8 days before parturition.....	1
Total.....	21
Number of regulations prohibiting the sale of milk	
15 days after parturition.....	1
10 days after parturition.....	6
7 days after parturition.....	1
5 days after parturition.....	11
4 days after parturition.....	2
Total.....	21

Fines

Number of regulations prescribing fines or penalties.....	22
Number of regulations not prescribing penalties.....	7
Fines in regulations studied varied from \$5 to \$300	
Jail sentences mentioned 10 days to 3 yrs.	

Construction of utensils

Number of regulations which require that only utensils with smooth joints be used.....	2
Number of regulations which require that utensils be made of non-absorbent material.....	2
Number of regulations which require that utensils be well constructed.....	6

Cleaning of Utensils

Number of regulations requiring that utensils be	
Clean.....	17
Washed.....	6
Scalded.....	3
Sterilized.....	3
Used for no other purpose.....	7
Protected from contamination.....	2

Number of regulations represented in the above items.....	21
Number of regulations not referring to the cleaning or care of utensils.....	8

Milk plant

Number of regulations requiring that milk plant	
Be clean.....	5
Be free from odor.....	1
Have a certain score (Score required, 50).....	1

Wagons

Number of regulations requiring that driver be free from disease.....	5
Number of regulations requiring that	
Wagon be covered.....	1
Wagon be clean.....	3
Wagon not to be used for any other purpose.....	1
Name of dealer must appear on wagon.....	6
License number must appear on wagon.....	4

Street milk

Number of regulations requiring that milk must be sold in bottles only.....	1
Number of regulations requiring that bottles must be covered.....	1

Store milk

Number of regulations requiring that milk be sold in bottles only.....	2
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Milk tickets

Number of regulations requiring that milk tickets be used but once.....	1
Number of regulations which do not limit the use of tickets.....	28

Skimmed milk

Number of regulations which require that cans and bottles be marked.....	15
Number of regulations prescribing heights of letters.....	11
Number of regulations requiring letters	
2 inches in height.....	1
1 inch in height.....	8
$\frac{3}{4}$ inch in height.....	1
$\frac{1}{16}$ height of container.....	1

Milk bottles

Number of regulations requiring that bottles	
Be sealed before using.....	2
Have name of dealer blown into bottle.....	4
Be cleansed immediately by consumer.....	2
Be filled at plant only.....	2

Bottle caps

Number of regulations requiring that date of bottling be printed on bottle caps.....	1
Number of regulations requiring that bottle caps be clean.....	2

Farm regulations

Number of regulations requiring that cows be tuberculin tested.....	1
Number of regulations requiring that minimum score of dairies be required	4
Number of regulations requiring that minimum score of dairies be	
80.....	1
50.....	2
40.....	1

Cleanliness of cows

Number of regulations requiring that udders be washed before milking.....	2
Number of regulations requiring that udders be	
Wiped with damp cloth.....	1
Cleaned with dry cloth.....	1
Number of regulations requiring that udders be clean.....	8

Cow stables

Number of regulations specifying that stable be	
Clean.....	9
Well ventilated.....	7
Well lighted.....	5*
Number of regulations requiring that stables	
Be free from dust.....	2
Be free from manure and odor.....	5
Have tight sound floors.....	1
Have floors well drained.....	2
Have tight clean walls.....	1
Have tight clean ceilings.....	1
Number of regulations requiring the removal of manure.....	3
Number of regulations requiring removal once daily.....	2
twice daily.....	1
Number of regulations requiring that manure be removed not less than	
200 ft. from stable.....	1
Number of regulations calling for whitewashing stable.....	3
Number of regulations calling for whitewashing	
Every two years.....	1
Annually.....	2
Number of regulations stating that no animals other than cows be allowed	
in the stable.....	3

*Area of window space per cow not mentioned.

Milk house

Number of regulations requiring that milk house be	
Clean.....	6
Used for no other purpose.....	4
Well ventilated.....	2
Well lighted.....	2
Well drained.....	1
Number of regulations calling for sterilizing equipment in the milk house....	1
Number of regulations requiring that milk house be well screened.....	3
Number of regulations requiring that milk house be located a certain distance from the stable.....	3
Number of regulations requiring milk house to be "away" from stable....	3
Number of regulations requiring that milk house be free from odors.....	3
Number of regulations requiring that milk house	
Be a separate room.....	4
Be a distance from privy.....	1
Number of regulations requiring a location	
100 feet from privy.....	1
50 feet from privy.....	1
Away from privy.....	2

The milk

Number of regulations requiring that milk be removed immediately from the barn.....	2
Number of regulations requiring that milk be	
Cooled immediately.....	3
Aerated.....	1
Milked into covered pails.....	1
Number of regulations requiring that fore milk be discarded.....	1
Number of regulations requiring that milk be stored only in milk house....	3
Number of regulations requiring that milk be graded.....	1

Milk straining

Number of regulations requiring that milk be strained immediately.....	1
Number of regulations requiring that milk be strained	
Through cotton.....	1
Through flannel.....	1
Through wire.....	2

The milker

Number of regulations requiring that milker be	
Free from disease.....	6
Clean.....	4
Wear clean clothes.....	2
Wash hands before milking.....	1
Number of regulations requiring that milking be done with clean dry hands..	1

Barnyard

Number of regulations requiring that barnyard be	
Clean.....	3
Well drained.....	1
Free from manure piles.....	2
Free from stagnant water.....	2

Water supply

Number of regulations requiring that water supply be	
Clean.	4
Fresh.....	2
Free from contamination.....	2
Pure.....	2

Pasteurized milk

Number of regulations requiring that pasteurized milk be labeled.....	1
Number of regulations specifying that in pasteurizing milk be heated and held for a certain time and at a given temperature.....	3

In conclusion, your committee would state that it does not understand it to be within its province to outline or to present recommendations at this time for the correction of the glaring irregularities so frequently observed in regulations pertaining to the same subject; but out of this survey of milk and cream regulations of the cities and towns and states of the United States, with a full realization of the magnitude of the industry and the factors which make for improved quality, this committee has become convinced that

First, there is a great and urgent need for further research and study on the part of our dairy investigators of some of the problems involved in the production and handling of milk; and

Second, there is a great and urgent need that definite information now available be placed in the hands of all who are responsible for the laws and ordinances governing the production, transportation, handling and sale of milk.



PRESIDENT'S ADDRESS

W. A. STOCKING, JR.

Delivered before the American Dairy Science Association

Springfield, Massachusetts, October, 1916

Mr. Chairman and Members of the Official Dairy Instructors' Association:

We meet today for our eleventh annual meeting (second session) since the organization of this Association in 1906. During the years that the Association has been in existence, much progress has been made in the methods of teaching dairy industry, in the development of scientific truths, and in their application to commercial dairy work. During this period conditions affecting the dairy industry have changed greatly and are still changing rapidly in many sections of the country. We still have many difficult problems to meet which will require the best talent available, both in our teaching and research work, and in our relations with commercial dairying.

It has been difficult for our departments to keep up with the demands placed upon them. The call for well trained men for teaching and research work has been strong, and has increased with the years. At the same time progress toward a higher grade of dairy products has developed the need in commercial work for men with good training in dairy chemistry and bacteriology. Commercial concerns are recognizing more and more the potential ability in young college graduates and the demand for them is increasing. Men with business foresight, recognizing the value of training, are taking our most promising graduates at salaries higher than can be paid by colleges and stations. Nor have they failed to recognize the commercial value of men with years of training and experience in actual teaching and research and are drawing men away from the colleges into commercial work, under financial inducements with which the colleges are not yet able to compete.

In many instances, this situation is resulting in our departments being forced to use men of second grade, to fill positions as assistants and instructors, and at the same time lose their older and stronger men—men whose experience and judgment is vital to the maintenance and development of the department's work.

This results in a critical situation, and I believe we must face squarely the question as to the future of the profession of teaching and research, in the field of dairy industry. With the strong call for men in commercial work, many of our best students fail to see the advantages of graduate training. Is this due simply to the allurements of commercial work with the prospect of a career of business activity or partly due to the attitude and vision of our dairy instruction. In business, so in teaching, it is a good thing to take an inventory occasionally and see just where we stand. In each State, the courses of instruction have developed gradually from rather small beginnings. As the work has developed, many new courses have been added, and I believe that we can feel just pride in the progress that has been made.

But it is easy to drift and I believe we should challenge our work and determine anew our relation to the industry which we represent.

Are we furnishing the kind and the quality of instruction which is needed? The work of a dairy department covers a broad field, involving as it does all questions pertaining to the development and care of the dairy herd; the production and handling of milk for direct consumption, and the manufacture of dairy products of various kinds. While in a general sense our industry is an applied one, it rests heavily upon several fundamental sciences including the principles of plant and animal growth, animal breeding and nutrition, physics, chemistry and bacteriology. The man who fits himself thoroughly for teaching and research in the general field of dairying must have a very broad foundation. This is very different from the man who is fitting himself for work in a single science, such as chemistry or entomology. When the men who are now prominent in dairy work received their college training, the bachelor's degree, or at the most, a master's degree was all that was considered necessary,

and it is probably safe to say that most of us feel our limitations because we did not have more training in one or more of the group of sciences mentioned. True, this is a day of specialists and specialization and the teacher is limited to a relatively narrow field of work. However, I believe the urgent demand both now and in the future will be for men with greater training, and the man who now contemplates entering our field of teaching or investigation should have at least the amount of training necessary for the Ph.D. degree. It is an encouraging sign that men with this kind of training are beginning to appear in our dairy departments.

A serious problem for us to consider is how we are to persuade our most able graduates that here is a field of work worthy of their continued study and best efforts. This raises at once the question of the type of graduate instruction which we are prepared to give.

With the development of the dairy industry the relative importance of the different branches of the work has changed. In the early days the problems of the greatest interest to the dairy farmer were those having to do with the development and maintenance of his herd. Now the average farmer is fairly familiar with the principles of breeding and of feeding and problems of quality of products and methods of marketing are of increasing importance, in fact, in many sections, are today the vital issues. In theory, it is very well to make two blades of grass grow where one grew before, or in the language of the dairymen, "make two quarts of milk flow where one flew before," but history has shown that increase in production may be accompanied by a decrease in profit to the producer. Unless the second blade of grass, or the second quart of milk, can be produced at a profit, its production is of no advantage to the farmer. Fifteen or twenty years ago butter and cheese represented the normal outlet for the farmer's milk, and this is still true in some sections where markets are far away, but in many sections today, the conditions have changed and the farmer's outlet is in the form of market milk for direct consumption, or in the production of some of the newer products, such as ice cream, fancy cheeses, con-

densed or powdered milk. These changes in commercial conditions require corresponding changes in our instruction and we should consider carefully whether or not we have developed our courses of instruction to meet this evolution, and are turning out men qualified for responsible positions in these lines of commercial work. This involves, in some cases, swinging the emphasis from the dairy cow to the handling of her products, and, while the cow is today no less important and no less interesting than formerly, we must recognize the increased importance of a thorough knowledge of the best methods of handling her products. Meeting the new situation in some cases may involve a reorganization of our courses of instruction. How many of our departments are now giving thorough courses in the handling of market milk, or the making of condensed or powdered milk?

In the field of research, our dairy departments have done much work of the greatest value and we are all indebted to many of our members for the results they have accomplished. A review of the literature will, I think, impress us with the fact that most of the best research work of our departments has been along lines relative to the development and care of the herd rather than the handling and disposition of the products. It is true that there are some notable exceptions to this statement, but I wish to raise the question as to whether the time has not now come when more of our departments should be devoting at least a part of their efforts to research work in connection with the handling and quality of our dairy products. Take, for example, the problems connected with production of milk of the sanitary quality now demanded by our cities and health officials. Who knows the conditions that are really essential for the production of milk of a specified germ content? You may say at once that these things have been established by the work of certain investigators, the quality of whose work is recognized and respected by all, but without casting the slightest reflection upon work already done, I wish to emphasize the importance and the necessity of duplication of research work by different men working independently and in widely separated regions. Our pres-

ent beliefs regarding the breeding and feeding of the dairy cow have not grown out of the results of one or even a half dozen able workers. Why should we draw equally important conclusions regarding essentials for the production of sanitary milk from the work of a smaller group, even though equally able men? I do not believe that duplication of research work is to be deplored or regarded as an unwise expenditure of University, State, or Federal funds, at least until we have far more information than is now available along the lines of sanitary milk production and the biology of dairy products, and until the work has been checked by a number of independent workers.

One of the perplexing problems of the dairy departments today is their relation to the farmer and our so-called extension work. I am sure no one fails to recognize the great value of this line of Dairy Instruction, and the fact that it is of great productive importance to our industry. But with the urgent and ever-increasing demand for this type of work, I fear there will frequently be a strong temptation for the Departments to so divide their energies that resident instruction to the regular students will suffer. The question of whether the men responsible for the teaching of regular students should also do extension work, and if so, to what extent, is a most important one. Certainly in our college teaching we do not want to lose touch with the man on the farm. Equally true it is that we do not want to model our university teaching after the type needed by the man on the farm, or the short course student. It is not an easy matter to keep the proper balance between these two types of instruction, and we should take great care that one does not develop at the expense of the other.

One of our difficult problems today is that of training the men who will stand responsible for dairy instruction in the future. Are we providing in our departments an atmosphere of study and research which will appeal to our best students? The opportunities in the field of dairying are large and justify their taking the necessary graduate study in preparation for this work. Until our colleges can meet the opportunities offered by commercial work, the great need of the industry is able teachers and

investigators who will enter this field of work with the clear understanding that they will not receive high or perhaps even adequate financial compensation, but that they are devoting themselves to the advancement of truth and the betterment of mankind.

ON THE FORMATION OF "EYES" IN EMMENTAL CHEESE¹

WILLIAM MANSFIELD CLARK

*From the Research Laboratories of the Dairy Division, Bureau of Animal Industry,
United States Department of Agriculture*

INTRODUCTION

The quality of a prime Emmental cheese is determined not alone by its sweet, nutty flavor and pliant texture, but also by the character of its holes.

Cracks, which frequently mar the appearance of a cheese, are intimately connected with a faulty texture. So too are the holes dependent upon proper texture for their shape; but, while the holes have a more or less spherical form as if distended by a gas in a plastic medium, there are important distinctions superficially based upon their size.

The normal "eyes," familiar to every lover of "Swiss cheese," vary from the size of a hazel nut to that of an English walnut. When uniform in size and distribution they give "The King of Cheeses" a distinction admired by the connoisseur. To quote the words of an authority (24) on the manufacture:

Beim Anbohren entschlüpft dem Kenner ein bewunderndes "Ah," wenn sich auf dem Böhrling zwei bis drei mattglänzende, sauber ausgearbeitete Augen von ein bis zwei Centimeter Durchmesser zeigen.

On the other hand there frequently occur large "blow holes" which not only may mar the contour of a cheese, but which sometimes are associated with an "off flavor." Last and worst are "die Nissler," "the thousand eyes," the "pin holes," which frequently ruin a cheese by making it spongy, and which always detract from its commercial value even when present in small number.

There is also a marked difference in the times at which the various classes of holes develop. So many apparent anomalies

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occur in cheese making that generalizations are dangerous, but, with a fair degree of truth, it may be said that "Nissler" holes develop while the cheese is under press or directly after; while normal eyes seldom start until the cheese is at least a week old. Again large holes seldom develop in press. They generally become evident later, and instances are noted by the European writers where they develop after normal eye formation.

Aside from the superficial distinction of size there are certain more fundamental differences of origin. Nissler holes undoubtedly have their origin in a gaseous fermentation of the sugar of fresh curd. Such a fermentation may be produced by bacteria or yeasts. When caused by bacteria the abnormal fermentation is revealed by the gaseous content of the holes, for it was shown by Clark (6) that the gas of Nissler holes may contain a large percentage of hydrogen, while that of normal eyes contains none. Various attempts have been made to distinguish the fermentations responsible for various types of holes. The greatest success has been met in the study of Nissler holes, for a number of bacteria and yeasts have been found whose gaseous fermentation of the sugar in fresh curd may clearly be held responsible. In like manner the formation of blow holes has been clearly traced in certain instances. The biological origin of normal eyes is still in doubt.

However, we are not now concerned with the bacterial origin of any of these openings, nor even with the texture of the cheese which is an essential prerequisite to their formation. The point to be discussed is merely the superficial distinction of size and its cause.

Granting that the distending gas in each case has its origin in a distinct fermentation, why should this superficial difference of size be so persistently characteristic? The time was when the different fermentations were far less clearly distinguished and the difference between pinholes, "eyes" and blow holes was considered to be merely one of size, and perhaps also of the period of cheese ripening in which they are formed. Baumann (2) made no other distinction than this and attributed the three general types of holes to the activities of the same organism.

Weigmann (33) adds:

Auf dem Gebiete der Käsegärung haben wir gefunden, das die Käseblähung in den meisten Fällen von gewöhnlichen Milchbakterien bezüglich Pilzen ausgeht und die normale Augenbildung und die Käseblähung physiologisch dasselbe sind und sich nur quantitativ unterscheiden.

We now know the distinction to be qualitative, but whether it is quantitative or qualitative the same question may fairly be asked: Why is it that gas holes formed "in press" are generally small and numerous while eyes which develop slowly are large and comparatively few?

If a well based reason for this shall be found, we may have gained a better view of the more general aspects of hole formation, and a firmer grasp upon the means of scientific control we hope to attain.

Aside from its intrinsic interest the determination of the factors which influence the size and spacing of the eyes is of direct practical importance inasmuch as there is evidence that preference is turning gradually toward a cheese with larger and fewer eyes.

In 1896 Bächler (1) described the ideal Emmental cheese as one having eyes 1 to 1.2 cm. diameter, 2 to 4 cm. apart. Peter and Held (24), in the 1910 edition of their text book, give the diameter as 1 to 2 cm.; as does Konradi (19) who visited the Swiss factories in the summer of 1912. Thus between 1896 and 1912 the maximum size of an ideal eye increased from 1.2 cm. to 2 cm.

Certainly the cheeses which sell as imported over the counters of our local markets are characterized by eyes fewer and larger than those described by the European writers; while the "domestic Swiss" have more and smaller eyes. Whether the European makers select cheeses with larger eyes expressly to meet the demands of the export trade; or whether there is a differentiation between all cheeses of domestic or foreign make, which if texture and flavor are equal, brands a small-eyed cheese as "domestic" and a large-eyed as "imported," it is difficult to say. Nor is it

essential to our purpose to discover, except insofar as the distinction in the market indicates a preference which the maker must meet.

In the following pages one very important factor in determining the size and spacing of holes will be presented.

THE RELATION BETWEEN BACTERIAL COLONIES AND EYES

It seems to have been assumed by many writers that, if bacterial action is the cause of the evolution of the gas, bacteria in sufficient numbers to produce this necessary gas must be strictly localized about a hole. This certainly is the most straightforward supposition to make; and, if true, it would seem as if a comparison of the flora about the eyes with the flora in other parts of the cheese would lead at once to the discovery of the organisms to which eye formation is due. Such comparisons have, however, not furnished the striking results we would expect.

That there does appear to be an unequal distribution of bacteria in hard cheeses is indicated by the investigations of several writers. Wigand (34) as early as 1884 stated that the bacteria in cheese are distributed in part as clusters. Inference of an unequal distribution was found by Duclaux (7) and by Troili-Petersson (31) in their observations that heavy inoculations from cheese sometimes gave no fermentation when smaller inoculations did.

Burri (5) describes a rare case in which dark colored colonies unassociated with "eyes" had become large enough to see.

Harrison and Connell (15) found a difference of 30 per cent in the bacterial content of different regions of Cheddar cheese.

In judging the value of the methods of study used in the investigations mentioned above it must not be forgotten that the transference of bacteria to artificial media for the purposes of counting and cultural tests is accompanied with the presentation to the bacteria of very different conditions from those found in cheese. None of the artificial media so far devised approximates exactly the relative great power of cheese to preserve a more or less constant hydrogen ion concentration with

the consequent extension of growth and the control of enzyme action. Nor do artificial conditions always simulate cheese in furnishing the proper degree of anaerobiosis. Thus an organism or its liberated enzymes may be able to produce in cheese much more CO₂ than in artificial media; and, as the limits of growth and action are reduced by artificial media, large differences in gas producing power may become narrowed to such an extent that the powers of different organisms may appear the same. It may therefore be true that some of the organisms isolated from certain regions, although culturally appearing identical in number and kind to those isolated from other parts of the cheese, may indeed have far greater CO₂ producing power when growing in cheese.

Jensen (18), upon comparing the number of bacteria on the walls of eyes and in parts of cheese distant from eyes found no striking difference. In fact a glance at Jensen's table shows that often the preponderance was in favor of regions of the cheese distant from the eyes.

But let us see what evidence direct microscopical observations present. Upon the unequal distribution of the bacteria, as seen in cheese sections, Beijerinck (3), Maggiora, (22) Troili-Petersson (30), Harrison, (14) and Percival and Mason (23) agree.

Gorini (13) determined the distribution of bacteria in Grana cheese by sectioning both fresh samples and samples hardened with alcohol. He found bacteria in enormous numbers and their distribution he grouped under two classes. The first class was that of dissemination, that is, a more or less uniform distribution of uncolonized organisms. In the second class were grouped the large colonies similar to those of plate cultures.

Rodella (25) supplemented the ordinary methods of histology by pressing cubes of cheese between two glass slides and staining the cheese which adhered to the glasses when they were withdrawn. He came to much the same conclusion regarding the distribution of bacteria.

The unequal distribution, as Gorini pointed out, should make us skeptical of "counts" as ordinarily made; not only because of the difficulty of obtaining a homogeneous sample with such

an imperfectly soluble substance as cheese, but because the bacteria are so unevenly distributed. This should add to the value of the direct microscopical methods, although Boekhout and Ott de Vries (4) have protested that the scattered bacteria found in sections may have been smeared off the colonies by the knife, and Troili-Petersson suspects that many of those seen are the borders of colonies on other sections. On the other hand Boekhout and Ott de Vries claim, that many of the colonies they observed in Edam sections were of dead bacteria, and consequently were not ripening centers. To this Löhnis (20) replies that ripening may not depend upon the living bacteria but upon their liberated enzymes. Whether such enzymes are able to diffuse from the centers where they are produced may be open to question; although from analogy with the ripening of soft cheese, where it is certain that the enzymes of surface moulds penetrate slowly toward the center, we must assume that they do.

The weighed evidence of microscopical examination supported as it is by Rodella's supplementary method, seems to indicate rather clearly that the bacteria are grouped in large clusters.

But the point in question is whether these colonies are correlated with the holes. Troili-Petersson (30) found lying in the walls of the holes of Swedish "Güterkäse" long slender colonies of bacteria spread out parallel with the walls. This vegetation, however, appears not to be of any one species of bacteria, and the form and size of the colonies may have been simply due to their having the space in which to spread. Beijerinck (3) who made sections of Edam cheese expresses the opinion that the accumulations of colonies of bacteria and crystals of tyrosin, etc., which he observed are due to local causes but he speaks of no relation between colonies of bacteria and the gas bubbles he observed. Maggiora's (22) description of sections of overripe cheese give no further information. Rodella was more concerned with the relation of bacteria to ripening than with localization, and furnishes little information upon the point we are interested in. But Gorini (13) mentions in particular that no constant relation between these accumulations and the small cracks and holes of Grana cheese was observed.

It therefore appears that direct microscopical examination has afforded very little evidence to support the view that eyes develop where colony growth is greatest. In fact it is perhaps not pedantic to say, that, even if these methods had enabled us to observe strikingly greater aggregations of bacteria about holes they would afford no conclusive evidence on the point at issue since they do not take into consideration the physiological powers of the organisms. This leaves the results of microscopical examination open to the same objections previously made against the cultural studies so far used.

Clark (6) has shown that not only regions about eyes but solid parts of cheese distant from eyes are active in the production of gas. In the experiment described the eye regions were, indeed, the more active; but in another experiment conducted since the publication of the first, no difference was observed. These observations, combined with the fact that the solid cheese mass itself contains very considerable quantities of CO_2 , invalidate any such calculation as that made by Jensen (18) in one of his earlier papers in which he attempted to show that the gas produced by Freudenreich's *Bacillus E* was sufficient in that it furnished somewhat more than enough gas to fill the "eye" space of an ideal cheese.

Until the specific origin of the gas is more definitely known, and until these bacteria have been located in greatest abundance at points of eye formation, or their liberated enzymes have been shown to have their action confined to these localities, the evidence at hand is in favor of the view that the gas is produced more or less evenly throughout the whole body of the cheese.

One further argument is almost sufficient of itself. If eyes start about colonies, how is it that these colonies are so sparsely distributed? In a prime cheese of 1896 the eyes according to Bächler (1) were rather evenly spaced 2-4 centimeters apart. With the development of the modern large-eyed export cheeses, the spacing of the eyes has increased greatly. *Yet colonies of bacteria occur so thickly distributed that they may be seen in almost any microscopic section.*

THE FORMATION OF GASEOUS AGGREGATES

There is really little reason, as well as little evidence, to support the assumption that the gas *necessarily* separates as gas bubbles where it is produced. It is not at all irrational to suppose that the gas, having first saturated the cheese mass, separates at advantageous points which have no *necessary* relation to those localities rich in bacterial growth. In other words we may suppose a process similar to the growth of crystals to take place.

Everyone is familiar with the principal phenomena of crystallization, with the fact that to start crystallization from supersaturated solutions it is often necessary to "seed" them, and with the fact that the slower the rate of separation the larger are the crystals obtained.

A step nearer the point we are concerned with is found in the case of rain formation. Lord Kelvin (28) showed that the vapor pressure over a curved surface differs from that of a plane surface. If the curvature is convex the vapor pressure is greater than that of a plane surface. Neglecting the very important factor of electrically charged nuclei, raindrops must therefore form first upon some object such as a dust particle which presents a surface more nearly plane than that of a minute droplet. Were a minute droplet to be formed in an atmosphere just saturated with its vapor, the curvature of its surface, and consequently its vapor pressure, would be so large that it would immediately evaporate while condensation were still taking place on larger drops and dust particles. Thus we may say large drops are formed at the expense of small ones.

Attention should be called to the fact that the alteration in vapor pressure is exceedingly small until the drop becomes exceedingly small, with a diameter of perhaps a millionth of a centimeter; nevertheless the difference is sufficient to prevent the precipitation of innumerable minute droplets from the atmosphere and to determine the growth to a larger size of drops already formed.

With only slight modification Lord Kelvin's treatment of the vapor pressure at curved surfaces may be applied to the gas pressure at curved surfaces of a gas in solution.

Using Lord Kelvin's diagram, figure 1, let it represent a closed space containing an aqueous solution of carbon dioxide with plane surface at *B*, a capillary tube in which this solution rises to the point *A* where it retains a concave meniscus. Let the remainder of the space contain only gaseous CO_2 and water-vapor.

Let us assume that the density σ of the carbon dioxide remains uniform throughout the height h , and that it is acted upon by gravity with the constant acceleration g . Let the pressure of the carbon dioxide in its liquid phase be w at the plane surface *B*, while at the curved surface *A* it is w' . Then w' must be less

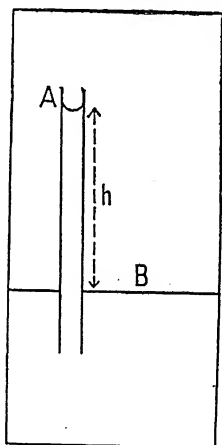


FIG. 1

than w by $g\sigma h$. Were it not so, CO_2 would distill from *A* and condense at *B* and work could be obtained contrary to the laws of thermodynamics.

Since vapor pressure and surface tension are related it may be profitable to look at this matter in another way. The pressure P tending to keep a bubble of gas spherical when suspended in a liquid is $P = \frac{2S}{a}$ (Willows and Hatschek) (32) in which S is the surface tension of the surrounding film and a the radius of the bubble. Since P balances the surface tension the pressure of the inclosed gas must overcome the surface tension if the bubble is to expand, but since P is inversely proportional to the radius

of the bubble, it is more difficult for very small bubbles to grow than for large bubbles.

If the separating gas already finds a film of gas, it will separate there rather than overcome the enormous force necessary to form *de novo* a tiny bubble.

This explains the observations frequently noted that any body having an adhering film of gas becomes covered with bubbles when placed in a solution saturated with gas.

There is then a striking analogy between the growth of crystals, the formation of rain drops and the growth of gas bubbles in a solution; an analogy whose physical manifestations are numerous and whose theoretical basis has long been accepted.

The quantitative estimation of the relationships established has been purposely avoided in the above treatment, because it would be difficult to apply them to such a heterogeneous substance as cheese or even to colloidal gels such as those of agar or gelatine. Nevertheless there is no reason to suppose that the principles do not apply to such gels; and by using these viscous media, which are capable of retaining gas bubbles as water solutions can not, we may obtain some striking verifications.

THE SEPARATION OF GAS AT POINTS DISTANT FROM THE SOURCE

If a sterile nutrient sugar solution of agar or gelatin be sown while molten with a pure culture of some gas-producing bacillus, such as *B. coli*, and then allowed to set, the gas liberated after a period of incubation separates as bubbles which are held in suspension. It can then be clearly seen that numerous colonies of bacteria have developed at some distance from the gas bubbles. The logical conclusion must be that the gas after having saturated the gel does not necessarily separate where formed, but tends to diffuse and separate into a bubble already started at some advantageous point. A more striking example is to be seen in the following experiment:

A hot sterile non-nutrient agar solution was poured into a sterile test tube, and when sufficiently viscous to retain a bubble of gas in suspension, such a bubble was introduced by blowing through a sterile

cotton-plugged glass capillary. To seal up any channel left by withdrawing the capillary a layer of hot sterile agar was poured upon the first. When this was thoroughly set an emulsion of nutrient agar and *B. coli* was poured on top. It was found that after a period of incubation, when the bacteria were presumably producing gas very vigorously, the pre-formed bubble in the non-nutrient agar increased very markedly in size. This experiment was repeated several times with uniform success. It may justly be taken to illustrate the hypothesis that the gas in a saturated colloidal gel will obey the principle deduced for pure aqueous solutions, namely, that large bubbles will be formed at the expense of small.

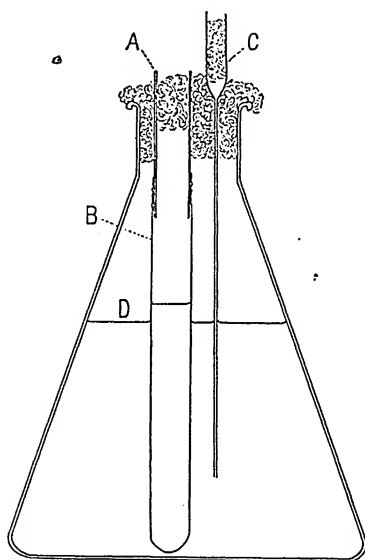


FIG. 2

In the above experiment it might be claimed with justice that into the original agar jelly there diffused sufficient food material for the bacteria to produce gas there; but it is improbable that within a few hours the bacteria in the supernatant culture could grow into, or by any probable means find their way into, the region where the initial bubble was blown. Indeed no growth about the bubble was observed.

In order to definitely preclude this source of error, the following arrangement was made (see fig. 2):

A collodion sac *B* was cemented with collodion to the glass tube *A*. It was then suspended in an Erlenmeyer flask. A nutrient sugar medium containing 1 per cent agar filled the Erlenmeyer within and without the sac to the level *D*, this level being considerably below the point where the sac was cemented to the glass tube. A very fine capillary tube *C*, with its upper end tightly plugged with cotton was then placed as illustrated, and the neck of the flask tightly plugged with cotton. The whole apparatus was then sterilized in an autoclave.

While the agar was still molten and at a temperature of about 40 degrees, that in the sac was inoculated with *B. coli*; and, when the agar on the outside of the sac was sufficiently viscous to hold gas bubbles in suspension, a few were blown in it by means of the capillary tube *C*. This capillary was then withdrawn. When all the agar had set, this flask was left at room temperature (about 22°) to incubate the bacteria.

As in the former experiment the pre-formed bubbles grew in size. The collodion sac was found to be intact at the close of the experiment. It had purposely been made rather thick to prevent the bacteria making their way through it. The above experiment was made in duplicate with like result.

Although Todd (29) found that collodion membranes were not impervious to *B. coli*, Fuller (11) the next year (1910) obtained results entirely at variance with those reported by Todd. Using Frost's (10) method he found it possible to make sacs which retained their bacterial integrity for several months. The same conclusion seems to have been reached by Heymans (17) (1912).

Although the experiments of Todd and Fuller contradict each other, it should be remembered that both investigators used fluid media while in the above experiment the medium contained 1 per cent agar. The collodion thus served simply as an additional barrier. Frost using *B. typhosus* and *B. pyocyaneus*, two organisms which Todd claimed penetrated collodion sacs, found that when the sac was embedded in gelatin, the organisms were retained perfectly.

There is then, every reason to believe that the bubbles which grew outside the sac and which were indeed more than 2 cm. from the sac were thoroughly separated from any bacterial contamination.

But if the proposed explanation be true, there follows an almost necessary corollary. To induce growth of a crystal time must be allowed for delicate adjustment of equilibrium else new crystals will be formed soon to compete for the substance in solution upon an equal basis with the first formed crystals. In like manner the rate of gas production must be low if a bubble already formed is to grow without competition, for if the gas is formed rapidly it can not become diffused and distributed from the points of production rapidly enough to prevent supersaturation of these regions. When this supersaturation becomes sufficiently great the gas must separate from solution. Consequently when the rate of gas production in a culture is rapid many small bubbles will be formed; and when the rate is slow the tendency will be toward the formation of larger aggregations or larger bubbles.

An illustration of this is furnished by Mr. Ayers of this laboratory. In some studies on the Wisconsin curd test Mr. Ayers found that curds containing numerous gas producing bacteria, and consequently subjected in general to a high rate of gas production, were filled with numerous very small holes, while curds containing fewer bacteria, and consequently subjected to a lower rate of gas production, were inflated with larger holes. It may of course be said that the number of holes correspond to the number of colonies; not a numerical correspondence, for such does not occur, but a parallelism. On this basis we might perhaps explain Mr. Ayers' observations by saying, that when a certain number of colonies in a thickly seeded culture have formed a small bubble, other groups of colonies throughout the medium have done likewise and at the same time have formed sufficient acid to prevent further growth of bacteria and consequently further gas formation. The result would then be numerous small bubbles. On the other hand if the colonies are very much less numerous the surrounding regions would furnish by diffusion both more food per colony and more absorption of acid per colony. In consequence, large holes would be produced. This explanation while plausible is only partially justified. In the first place there is no numerical correspondence

between the number of colonies and the number of holes as can be seen with the naked eye in a clear gelatine culture of *B. coli*. It must therefore be granted that the gas, before it separates, actually does diffuse from the points where it is formed. Postulation of extra-cellular gas-producing enzymes would only emphasize this, since such enzymes if at all diffusible would be even more widely distributed than the bacteria. But in the second place, the writer has found that of two 200 cc. flasks of the same gelatine media each inoculated with 760,000,000 bacteria, that kept at 15° had larger gas holes than that kept at 20°. It is difficult to explain this except on the basis that the 15° culture had a lower rate of gas production which allowed time for larger bubbles to grow just as in the crystallization of salts the larger crystals will be formed during the slower crystallization.

Although factors other than the rate of gas production may influence the size and number of gas holes in a culture, the chief factor seems to be the rate.

APPLICATION OF THE PRINCIPLE TO CHEESE

It therefore follows that a rapid production of gas in cheese would result in the formation of numerous small holes, while with a slow rate the holes would tend to be large. In general it may be said at once that such a relationship does occur. The Nissler holes of Swiss cheese are small, and they are formed rapidly. The eyes are only formed after some time has elapsed, and grow with extreme slowness.

At this point it may be well to comment upon some objections which have doubtless occurred to the reader. In the first place are there not in cheese a sufficient number of gas bubbles enclosed in the curd during the manufacture to furnish innumerable gaseous nuclei for the separation of innumerable bubbles instead of relatively few "eyes." Examination of curd grains in the kettle do indeed sometimes show that they have adhering to them bits of froth, but it must be remembered that when the cheese goes to press its temperature is high and that these tiny bubbles may be absorbed when the cheese cools. If one blows *tiny*

bubbles in a viscous solution of agar (40°) or in a fairly warm gelatine solution, these bubbles will be seen to entirely disappear as the solution cools—provided of course the bubbles were originally not too large. There can be little doubt that a like absorption takes place in cheese.

It may further be questioned whether the solid particles of cheese do not furnish innumerable nuclei for the separation of gas bubbles just as dust in the atmosphere furnishes the nuclei for the condensation of rain. To this question we have a positive answer in the experiments of Gernez (12).

Gernez found that in the separation of gas from supersaturated solutions solids alone do not serve as nuclei. A film of gas upon the solid surface is an absolute essential. If a glass rod is plunged into a supersaturated gas solution bubbles are formed upon those surfaces which had been exposed to the air; but if the rod is broken while in the solution no bubbles form upon the freshly exposed surface. Likewise, precipitates if formed in gas-free solutions, do not serve as nuclei for bubbles when placed in supersaturated gas solutions. It appears then that a solid, if it is to serve as a nucleus for a gas bubble, must have a surface film of gas.

We are therefore justified in believing that the cheese curd goes to press with few so-called nuclei of any kind which may induce the growth of gas holes.

But let us see what further evidence there is that the formation of gas holes in cheese does follow the analogy to crystal growth which has been proposed.

Freudenreich (8) in his cheese making with *B. Schafferi* found that this organism could produce Nissler cheeses and also blown cheeses; and he therefore considered that these faults are not necessarily due to different bacteria.

Freudenreich's explanation was as follows: If the bacteria are allowed to develop to such an extent before the cheese is made that they are numerous and evenly distributed throughout the milk, Nissler holes are formed because there are numerous colonies. If, however, the cheese is made up directly after inoculation the colonies are fewer and the cheese develops

blow holes. Undoubtedly there is a good deal in this theory; but it should be asked if even in Nissler cheeses we are to assume the number of colonies equal only to the number of gas holes, and especially so when these holes are several centimeters apart. If we look over carefully Freudenreich's paper we shall find in the first place that his Nissler cheeses were those which gased in press while his blown cheeses took a week or ten days to blow; indicating that the time factor was an important one, and that what we may call the crystallization of the gas was the important factor. Furthermore it is significant that in at least one of Freudenreich's crucial experiments the bacteria introduced were not allowed to develop before but *after* the addition of the rennet. Now it is known that rennet acting upon pasteurized milk such as Freudenreich used in this experiment takes longer to produce a firm enough curd for cheese making; nevertheless it rapidly, sometimes more rapidly than in raw milk, produces a thin coagulum. Therefore in Freudenreich's experiment we would surely not expect the bacteria to have been scattered after the addition of the rennet but to have attained larger colony growths. If this assumption be correct we would have expected a blown cheese according to Freudenreich's hypothesis. Instead he obtained a Nissler. The simpler explanation appears to be that he obtained in this case colony growth of such extent that a rapid gas production took place, and that, in consequence of this high rate, the gas had to separate close to the points where it was produced.

Of course this interpretation must not be construed too rigidly. If there are present in the milk particles of cow dung, the infection of the cheese may become so rank at certain points that nothing short of a blow hole will be produced at these points. Jensen (18) actually observed this correlation and Freudenreich (S) found that paper pellets soaked in a culture of *B. Schafferi* produced blow holes in the cheese about these rank infections.

In such a case the gas, though it may separate at frequent points near its origin and though it may tend to produce a "Nissler" cheese can not stop short of the production of a "blown" cheese with large holes because of the abundance of the gas which

must separate. The holes of such *rapidly* blown cheeses however reveal the manner of their formation by the irregularity of their contour. They appear to have been distended by a more or less explosive gas production and are without that clean-cut, neatly spherical contour of the perfect eye, which results when time is allowed for the adjustment of tensions.

STAINED CHEESES

One test to which we may subject the hypothesis which has been suggested is the following: If Nissler holes are formed at the points where the gas is produced or even close to those points, then no particular locality in the cheese should be favored provided the bacteria are distributed both within and without the curd grains. On the other hand, if normal eyes are formed so slowly that time is given for the gas to assemble and separate at favorable localities, we should expect to find these localities to be of some definite nature.

That the bacteria in fresh curd are distributed both within and without the curd grains can not be doubted, although it may be that their numerical distribution differs. Harrison and Connell (15) state that upon inoculating milk with a gas-producing organism more of these were found on the exterior of the curd particles than within. Russell and Weinzirl (26) found fewer organisms in the curd than in the expressed whey.

On the other hand Hastings, Evans and Hart (16) find that the curd retains the greater part of the bacteria found in milk. These observations apply to Cheddar curd. Freudenreich and Jensen (9) observed that in the manufacture of Swiss cheese the greater part of the bacteria were to be found within the curd grains.

If it be permissible to draw a definite conclusion from this, it is that the method of manufacture of Swiss cheese, and especially the high cooking temperature, is least destructive to the bacteria within the curd. We should therefore expect the gas producers in a Nissler cheese to be distributed both within and without but predominatingly within the curd grains.

In 1896, Bächler (1), an experienced cheese maker, proposed that eyes are formed between curd particles. The writer has been unable to obtain a copy of Bächler's original paper but from abstracts has gathered that his view was as follows:

When the curd is hooped, if the whey is not thoroughly expelled from between the curd particles, pockets of whey will be retained. After the cheese leaves the press the whey from these pockets will be absorbed and a "weak" spot left. Whether Bächler meant an actual hole or a place where the curd grains were imperfectly matted is not clear. The latter interpretation is probably more just, for Bächler must have observed the irregular holes, so-called "mechanical holes," which sometimes occur in weakly pressed curd, and he would not have mistaken these for incipient eyes. A normal eye from the moment of its origin retains its characteristic spherical shape, and, when small, closely resembles a Nissler hole. It is probably imperfectly matted curd grains which Bächler meant by weak spots.

If this be so, it is obvious that a method of testing his hypothesis would be to so stain the surface of each individual curd particle that in the solid cheese its outline would remain distinct. If in a cheese so stained a gas hole should form *between* curd particles its interior wall would be *colored*; while if it should originate *within* a curd grain the interior wall would remain *uncolored*. An admirable dye for this purpose was found in Congo red. When this was sprinkled into the kettle just before the curd was drawn it stained the surface of each curd grain a uniform red and did not penetrate. A cross section of a cheese so stained revealed the distinct outline of each original curd particle.

Two stained Nissler cheeses were made by the addition of cow dung to the milk. Upon cutting these cheeses when taken from the press it was found that the gas bubbles were not correlated with any particular locality. In numerous instances they were clearly seen to be wholly within the curd particles, while in other cases they had pushed aside the walls and formed holes whose interior walls were stained.

On the other hand, stained and apparently normal cheeses which developed apparently normal eyes presented a very differ-

ent appearance when cut. Almost without exception the holes had the characteristic appearance of normal eyes, and *their interior walls were all without exception stained.*

There can be little doubt therefore that no particular locality is favored when Nissler holes form while, at least in the experimental cheeses, the eyes without exception developed between curd grains. This is in harmony with the hypothesis that the gas of Nissler holes, because it is formed rapidly, must escape from solution near where it is formed, while the gas of eyes, having time to diffuse and to keep a closer equilibrium between its gaseous and liquid phases, separates first at a favorable locality, and there forms an aggregate comparable with a crystal.

We must be careful to say that "at least in the experimental cheeses the eyes developed between curd grains." The dye used injured to a slight extent the matting quality of the curd, so that there may have been produced artificially those weak spots suggested by Bächler. If so, it alters in no way the validity of the argument that eye development takes place in favored localities, although some slight doubt may be thrown upon the conclusion that in an undyed cheese these places are between curd grains.

Closer examination of the eyes of dyed cheese reveals an interesting point. It was noticed that in a great majority of cases the interior walls of the eyes were not uniformly stained. A small portion was unstained and almost of as clear a white as an undyed curd grain. Inspection of the curd grains in the vat showed that they were generally uniformly stained but occasionally enfolded surfaces and occasional unopened cracks were detected whose surfaces the dye had not reached. An eye developing in contact with such a surface would have its interior wall only partially colored.

In regard to the nature of the localities at which the gas separates there is, beside the hypothesis of Bächler (1) that of Schaffer (27). Schaffer's studies of eye development as followed with the X rays led him to believe that the regions of eye growth were regions of sufficiently active proteolysis to allow the curd to be absorbed and give way to the expansion of the

gas. Schaffer tried to explain away Jensen's finding that there was no distinct difference in the composition of the cheese near eyes and distant from them; but, while we admit that Jensen's method of analysis was not very delicate, we must also admit that Schaffer's evidence is of somewhat dubious value.

Why any particular locality should be favorable to the development of a gas bubble it is difficult to say; but from the striking appearance of the eyes of cheeses stained with Congo red, it is very evident that the eyes *do* start at particular points. Whether or not the eyes originated between curd grains, the surfaces of the eyes ultimately involved the surfaces of the curd grains.

Perhaps the unequal coloring of the eye surfaces is due as suggested to an unstained surface being involved; perhaps it is due to some proteolytic effect such as Schaffer has suggested whereby the interior of the curd grains became exposed; perhaps the Congo red was reduced.

Whatever the situation may be, the fact remains that the stained cheeses clearly demonstrate a difference in the locality of Nissler holes and normal eyes, a difference which demonstrates the only point with which we are now concerned; namely, that a sudden evolution of gas will result in many small gas bubbles located where the gas is produced, that with a slow evolution of gas, separation takes place at favorable places only.

The position of any particular eye, its rate of growth and its ultimate size depend upon a great many factors. We have not considered the influence of the texture of the cheese, its permeability to gas, the tension of the rind, nor the influence of proteolysis, and of the fat content upon the surface tension of an eye surface. These all must be considered in time, and to prevent confusion each should receive attention separately. All of these factors however are merely modifying influences, and none affects the validity of the argument that the gas in separating into bubbles in cheese follows the same laws that it does in beer and the same laws that apply in different degree only in the separation of gaseous liquid or solid aggregates from their saturated solutions.

SUMMARY

A review of the literature reveals little or no evidence that the eyes of Emmental cheese are strictly localized at points of excessive bacterial growth. On the contrary the evidence of bacterial counts, and direct microscopical examination as well as the gas production of different regions of the cheese indicate a more or less uniform distribution of the eye distending gas.

Certain theoretical considerations are presented which lead to the hypothesis that the gas separates in aggregates according to laws governing the separation of gas from supersaturated aqueous solutions. This hypothesis has been tested upon viscous media with results directly applicable to the "eye" and "Nissler" hole formation in cheese.

It is concluded that the gas produced in Emmental cheese separates in aggregates whose localities have no necessary relation to the points where the gas is produced, that a rapid gas production must tend to the formation of numerous small holes while a slow gas production must admit the formation of larger holes. This conclusion is shown to agree with the fact that Nissler holes are produced by a rapid fermentation while eyes are formed slowly. This conclusion also suggests that the gas of Nissler holes must separate at numerous points near its point of origin without regard to any particular locality of the cheese; while the eyes must form at favorable points.

This was experimentally verified by a study of stained cheeses.

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THE INFLUENCE OF SALT ON THE CHANGES TAKING PLACE IN STORAGE BUTTER

R. M. WASHBURN AND A. C. DAHLBERG

University of Minnesota

INTRODUCTION

It is generally believed, and most experimental evidence supports this belief, that salt improves the keeping quality of butter. McKay and Larsen (1) give as one of the reasons for salting butter "to increase the keeping quality. . . . That salt is antiseptic is no longer a doubt. . . . so far as the keeping properties of butter are concerned it would be advisable to salt butter as highly as 6 per cent." In their own experimental work (2) salted butter kept much better than unsalted butter when held at 50°F. The sweet butter became cheesy and mouldy. Rahn, Brown, and Smith (3) secured similar results at 21°F. and also observed that the increase in acidity was greater for the unsalted butter. In salted butter held at 50° to 60°F., Larsen, Lund and Miller (4) found that lightly salted butter developed the greater degree of acidity and they associated the increase in acidity with the decrease in score. The most highly salted butter had the better keeping quality. On the other hand, Gray (5) proved that "butter containing low percentages of salt kept better than did butter of the same lot containing higher percentages of salt," when stored at -10°, 10°, and 32°F.

From the literature on the subject, it is apparent that the influence of salt on the keeping quality of the butter varies according to the temperature at which it is held. When held at temperatures which do not stop bacterial growth, the highly salted butter seems to keep best, the low salted butter next, and the unsalted butter has the poorest keeping quality. When held at temperatures which inhibit bacterial growth, the lightly salted butter keeps better than either highly salted or unsalted. No good reason could be found in the literature for the apparent inconsistency.

SCOPE OF THE INVESTIGATION

It has been the personal observation of many men that unsalted butter in commercial cold storage keeps as well as or better than salted butter. The experiment reported in this paper deals with this point and considers only salted versus unsalted butter. The butter was first held for the usual cold storage period in a commercial cold storage butter room and was then held for a short time at the usual ice box temperature. This latter treatment is comparable to that which commercially stored butter would receive before being consumed. At each scoring the usual bacteriological and chemical analyses were made so that probable causes of a possible difference would not be overlooked.

MAKING, STORING, AND SCORING THE BUTTER

The cream was sweet clean cream of good flavor. It was ripened without pasteurization or the addition of a starter to an average acidity of 0.58 per cent lactic acid. It churned in twenty to thirty minutes; the churning was stopped at the wheat kernel stage; the butter was washed twice; salted or not; and worked from twenty-three to twenty-seven revolutions in a Victor double roller churn. Half the butter of each churning was salted and worked, and the other half worked unsalted so that each sample of unsalted butter had an exact duplicate in the salted butter. It was then packed into 5 pound paraffined wooden butter drums lined with parchment paper. Enough of these containers were packed so that one from each lot could be taken out at every scoring. Initial data as to score, chemical and bacteriological analysis were obtained.

The butter was stored in the butter storage room of Booth Fisheries Company, St. Paul, at a temperature of -15°F . After 284 days ($9\frac{1}{3}$ months) in cold storage, it was then held for twenty days in a butter-cutting room at 58° to 60°F .

It was all scored by James Sorensen, Manager of the Albert Lea State Creamery and S. G. Gustafson, State Creamery Inspector. Some of the butter was also scored by A. O. Storvick of the Federal Dairy Division, and Chris Johnson, State Creamery Inspector.

INFLUENCE OF SALT ON SCORE

The scores given are based entirely upon the flavor. They are arranged according to churnings so that below each score of the unsalted butter is its counterpart containing salt. The deterioration is figured for a total of 284 days at -15°F ; and a grand total for the entire 304 days.

TABLE 1
Influence of salt on score

CHURNING	SALT	-15°F .				58°F .		TOTAL DECREASE
		Initial score	113 day score	284 day score	284 day decrease	304 day score	304 day decrease	
1	0	91.75	89.00	91.00	0.75	90.00	1.00	1.75
	2.51	90.75	88.00	89.25	1.50	86.00	3.25	4.75
2	0	91.00	89.75	90.00	1.00	90.00		1.00
	2.07	91.25	89.25	89.25	2.00	87.00	2.25	4.25
3	0	93.00	91.25	91.00	2.00	91.75	+0.75	1.25
	1.72	93.25	90.00	90.50	2.75	88.00	2.50	5.25
4	0	92.50	91.25	89.50	3.00	90.75	+1.25	1.75
	3.27	92.50	90.62	88.75	3.75	88.25	0.50	4.25
5	0	95.00	92.00	92.75	2.25	92.00	0.75	3.00
	3.79	92.75	92.25	90.25	2.50	87.50	2.75	5.25
6	0	94.25	89.75	89.50	4.75	90.00	+0.50	4.25
	2.41	94.00	90.50	89.25	4.75	87.25	2.00	6.75
Average.....	0	92.94	90.50	90.62	2.29	90.75	+0.12	2.17
	2.63	92.42	90.10	89.54	2.87	87.33	2.21	5.03
Difference in favor of unsalted.....		0.52	0.40	1.08	0.58	3.22	2.33	2.91

At the end of 284 days at -15°F ., the unsalted butter had lost 2.29 points in score while the salted had lost 2.87 points; a difference of 0.58 in favor of the unsalted butter. A difference in favor of the unsalted butter held true in five out of the six churnings and tied in the sixth, but since the average is of only six lots, such a small difference, 0.58, might be ignored, if it were

not followed by similar evidence in greater degree when held at the warmer temperature. While the results are contradictory to those of Rahn, Brown, and Smith (3), they are not comparable because these investigators failed to work the unsalted butter in its manufacture and the temperatures employed did not freeze it in storage.

During the twenty day holding at 58°F., the unsalted butter did not deteriorate noticeably in flavor for it averaged 0.12 points higher in score than at the start. The salted butter lost 2.21 points in score, a difference of 2.33 points in favor of the unsalted butter. The total decrease in the score of the unsalted butter was 2.17 and for the salted 5.08, a difference of 2.91 in favor of the unsalted butter. Every sample of unsalted butter scored 90 or above while every sample of salted butter scored below 90.

The comments of the judges on the butter are given in the following table.

The most common criticisms were metallic, oily, and fishy. These three flavors appear to be associated with each other. At the 113 day scoring, seven out of twelve packages were criticized as metallic and two as fishy; at the 284 day scoring two were metallic and eight were fishy; at the 304 day scoring none were metallic and ten were fishy. The metallic flavor had changed into oily and thence into the fishy flavor. Out of a total of 24 drums of each kind of butter scored, seven, or 29 per cent, of the unsalted were criticized as being fishy against fifteen, or 62 per cent, of the salted. The intensity of this flavor was usually more pronounced in the salted butter. After the twenty days holding at 58°F., the body of all six samples of unsalted butter was criticized as being weak and overworked, while only one of the salted samples showed this fault. No satisfactory explanation can be offered for this fact. The only difference in the composition caused by moisture loss during storage, was the 3.15 per cent (or 26 per cent) greater moisture content of the unsalted, which through freezing and warm holding may have caused the conditions noted.

TABLE 2
Judges comments on the butter

CHURN- ING	- 15° F.			55° F.
	Initial	113 day	234 day	304 day
<i>Salted</i>				
1	Tendency to fishy	Fishy	Fishy, slightly unclean	Fishy, bad
2	Tendency to fishy	Metallic	Slightly oily, slightly fishy	Fishy
3	Will not go fishy	Metallic	Slightly oily, slightly fishy	Fishy
4	Good	Metallic	Fishy	Fishy
5		Coarse, fishy	Coarse, unclean	Fishy
6		Fishy	Fishy, coarse	Fishy, overworked, body poor
<i>Unsalted</i>				
1	Dry	Rancid, metallic	Metallic, cheesy slightly unclean	Fishy, overworked, body poor
2	Good	Trifle rancid	Slightly fishy, slightly unclean	Fishy, overworked, body poor
3	Good	Trifle moldy, cheesy	Slightly unclean, metallic	Weak body, bitter, curdy
4	Good	Metallic, old flavor	Fishy	Weak body, overworked, slightly fishy
5	Extra fine aroma	Slightly metallic	Good aroma, slightly oily	Flat, storage flavor, weak body
6		Metallic	Slightly oily slightly fishy	Weak body, fishy

INFLUENCE OF SALT ON BACTERIAL ACTIVITY

Bacterial counts were made of the butter and the organisms classified according to their action on milk. The latter proved to be of little value.

The extreme variation in the initial counts make them of no comparative value. Between the initial and 113 day counts the bacteria had died out rapidly. At the end of 113 days every

sample of unsalted butter contained more bacteria than its salted duplicate and similar though less uniform results were obtained at the end of 284 days. The averages agree with the findings of Rahn, Brown, and Smith (3), that the initial count of the unsalted butter was the higher and that "the decrease in the cold storage samples is larger in the unsalted samples." The low

TABLE 3
Bacteria in thousands per cubic centimeter

CHURNING	SALT	- 15° F.					58° F.	
		Initial	113 day	284 day	Decrease	304 day	20 day changes	
							Increase	Decrease
1	0		320	448		5,280	4,832	
	2.51		672			4		
2	0	944	28	164	780	2,000	1,836	
	2.07	3,984	376	108	3,876	48		60
3	0	3,756	100	280	3,476	2,880	2,600	
	1.72	3,248	360	560	2,688	96		464
4	0	5,466	44	52	5,414	1,360	1,308	
	3.27	700	52	224	476	17		207
5	0	9,862	240	432	9,430	2,560	2,128	
	3.79	2,250	456	2,320	+70	144		2,176
6	0	10,560	26	176	10,384	1,600	1,424	
	2.41	3,464	54	272	3,192	10		260
Average.....	0	6,117	126	220	5,896	2,613	2,393	
	2.63	2,729	328	696	2,032	53		643

temperature was so important in preventing bacterial development that the antiseptic property of the salt played a minor rôle. The *Bacterium Lactis Acidi* withstood the adverse conditions better than all other organisms. Yeasts or molds did not increase at this cold temperature.

During the twenty days holding at 58°F. to 60°F., marked changes occurred in the bacterial content. Temperature and moisture conditions were favorable to bacterial growth and to

general decomposition. In the unsalted samples, *Bacterium Lactis Acidi*, *Oidium Lactis*, and two species of yeasts grew and increased the germ counts 2,393,000 per cubic centimeter or 1088 per cent, while in the salted samples the salt inhibited all bacterial growth and there was an actual decrease of 643,000 per cubic centimeter or 92 per cent in germ content.

The only organism which appeared regularly in every sample of butter was *Bacterium Lactis Acidi*. The average percent of the total number which was this organism is shown by the following table.

TABLE 4
Percentage increase *Bacterium Lactis Acidi* during storage

SALT	INITIAL	113 DAY	284 DAY	304 DAY
<i>per cent</i>				
0	82.19	98.98	99.69	99.60
2.63	96.50	99.83	99.59	100.00

Since the percentage of *Bacterium Lactis Acidi* increased during storage, they died out less rapidly than the other organisms. At the end of the experiment every sample of salted butter was a pure culture of *Bacterium Lactis Acidi*, while the unsalted butter also contained an average of 3000 yeasts and 5300 *Oidium Lacti* per cubic centimeter.

INFLUENCE OF SALT ON ACIDITY

In the following table the acidity of the butter is expressed as the number of cubic centimeters of a tenth-normal NaOH solution required to neutralize ten grams of butter using phenolphthalein as indicator.

From the above table it is seen that the initial acidity of the unsalted butter is uniformly higher, average 0.12 cc., than the salted. This is due to the fact that the salted butter contained a little less water and that the water itself is slightly acid to phenolphthalein. At the end of the 284 days at low temperature, the increase in acidity of sweet and salted butter is equal, but after holding at the warm temperature, the unsalted butter had

TABLE 5
Influence of salt on acidity

CHURNING	SALT	- 15° F.				58° F.		TOTAL IN- CREASE
		Initial	113 day	284 day	284 day increase	304 day	20 day increase	
	<i>per cent</i>							
1	0	1.36	2.05	2.15	0.77	2.72	0.59	1.36
	2.51		1.72			2.08		
2	0	1.50	1.50	2.04	0.54	2.56	0.52	1.06
	2.07	1.32	1.75	1.88	0.56	2.07	0.19	0.75
3	0	1.38	1.91	2.05	0.67	2.89	0.84	1.51
	1.72	1.29	1.77	1.83	0.54	1.85	0.02	0.56
4	0	1.38	1.72	1.83	0.45	2.47	0.64	1.59
	3.37	1.29	1.77	1.83	0.54	2.02	0.19	0.73
5	0	1.57	2.21	2.23	0.66	2.87	0.64	1.30
	3.79	1.39	1.98	1.94	0.55	2.25	0.31	0.86
6	0	1.50	1.66	1.93	0.43	2.78	0.85	1.28
	2.41	1.35	1.79	1.88	0.53	2.09	0.21	0.74
Average.....	0	1.45	1.84	2.03	0.58	2.71	0.68	1.26
	2.63	1.33	1.51	1.87	0.54	2.06	0.18	0.73
Amount of greater increase in un- salted.....		0.11	0.33	0.16	0.04	0.65	0.50	0.54

increased 0.53 more than the salted. This difference may be accounted for in two ways: (1) the action of milk lipase, an enzyme which causes an increase in the acidity of stored butter, according to Rogers (6), would be inhibited by strong salt solutions; (2) microbial growth in the unsalted butter which consisted of *Bacterium Lactis Acidi*, acid producing yeasts, and *Oidium Lactis*. The *Bacterium Lactis Acidi* might increase the acidity slightly by the lactic formed from the sugar; the yeasts by the liberation of free fatty acids (6); and *Oidium Lactis* by an action similar to that of the yeasts (7).

INFLUENCE OF SALT ON MOISTURE

In order that some of the results of the moisture determinations can be explained a table showing the relation of moisture to salt is also given.

TABLE 6
Influence of salt on moisture content

CHURNING	SALT	INITIAL MOISTURE	284 DAY MOISTURE	DECREASE
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	
1 {	0	15.92	15.23	0.69 :
	2.57			
2 {	0	15.06	14.58	0.48
	2.07	14.58	12.48	2.70
3 {	0	15.84	15.98	+0.14
	1.72	15.45	12.64	2.81
4 {	0	14.73	14.65	0.08
	2.27	14.40	11.47	2.91
5 {	0	15.05	15.05	0.00
	3.79	14.59	11.00	3.59
6 {	0	14.83	14.78	0.05
	2.41	14.01	11.92	2.09
Average..... {	0	15.24	15.05	0.19
	2.65	14.61	11.90	2.70
Per cent more moisture in unsalted butter.....		0.63	3.15	2.51

The initial moisture content of the unsalted butter averaged 0.63 per cent higher than that of the salted, the difference being quite uniform for the duplicates. During the total cold storage period, the unsalted butter lost only 0.19 per cent in moisture, while the salted butter lost 2.70 per cent, or the salted lost 2.51 per cent more moisture than the unsalted. Since the unsalted butter was a frozen solid very little loss in moisture would be expected. In as much as the salted butter lost heavily both in moisture and salt, there must have been a leakage from the inside to the outside. In other words, it could not have been frozen.

It is a principle in physics that upon cooling any salt solution, the water will freeze out or the salt crystallize out, depending upon the strength of the solution, until the salt concentration is 22.5 per cent and the temperature is -6.5°F . It then freezes into a solid mass. The butter was cooled below this freezing point.

This abnormal cooling of butter below the freezing point of its water solution without freezing it was also observed by Rahn, Brown, and Smith (3) who stored unsalted butter at 21°F . and found it unfrozen. They explained it by the phenomenon

TABLE 7
Relation of salt to moisture in the salted butter

CHURNING	INITIAL SALT	284 DAY SALT	DECREASE IN SALT	INITIAL BRINE CON- CENTRATION	284 DAY BRINE CON- CENTRATION	LOSS IN BRINE CON- CENTRATION	CONCENTRA- TION OF LOST BRINE
	<i>per cent</i>	<i>per cent</i>					
2	2.07	1.07	1.00	14.18	8.57	5.61	47.62
3	1.72	0.91	0.81	11.13	7.19	3.94	28.82
4	3.27	2.14	1.13	22.71	18.65	4.06	38.57
5	3.79	2.10	1.69	25.97	19.18	6.79	47.11
6	2.41	1.62	0.79	17.20	13.59	3.61	37.79
Average...	2.65	1.57	1.08	18.24	13.19	5.05	40.00

that "water, if kept quietly in clean, smooth walled containers, may be cooled to several degrees below the freezing point without becoming solid." A consideration of the relation of salt to water in the butter reveals a more probable explanation in this particular case. The butter lost 1.08 per cent in salt and 2.70 per cent in moisture and the concentration of this brine is 40 per cent. The concentration of salt in the water remaining in the butter decreased 5.05 per cent. During the slow, undisturbed cooling to -15°F ., the water had frozen out as ice and the salt remained in solution making a supersaturated brine. The freezing point of this brine was lower than the temperature at which it was held.

PROTEIN CONTENT

Analyses for protein gave almost as great a variation in the samples of different tubs from the same churning as there was between different churnings. Such an uneven distribution of the protein must have been caused by (1) high acid in the cream causing minute clots of casein to be formed; (2) churning in a short time which failed to break up these clots. The protein (nitrogen $\times 6.38$) content of the butter was unusually low ranging from 0.47 to 0.68 per cent, average 0.55 per cent. Churning to the wheat kernel stage and washing twice were the probable causes of this low protein content.

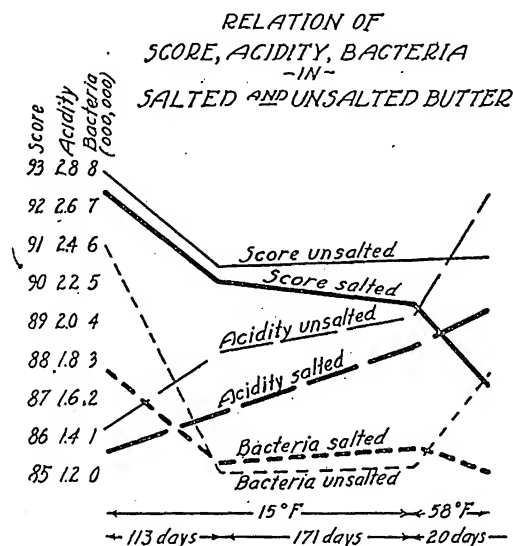
RELATION OF SCORE, ACIDITY, AND BACTERIA IN SALTED AND UNSALTED BUTTER

Score, acidity, and bacteria are popularly associated with each other. Conditions which favor a decrease in score favor an increase in acidity and bacteria. From the graph, it is evident that during the storage at -15°F . the changes taking place in the salted and unsalted butter were very similar. There was a decrease in score; a decrease in bacteria during the first half and the number remained constant during the last half of the storage period; and a gradual increase in acidity.

During the period of holding at 58°F . the changes occurring were very rapid and different. The unsalted butter remained constant in score, but the acidity and bacteria increased very markedly. The salted butter deteriorated rapidly in score; the bacteria decreased in number; and the rate of increase in acidity was only slightly accelerated. According to the generally accepted relation of bacteria and acidity to score, the score of the salted butter should have decreased less than that of the unsalted, but the results obtained were the exact opposite of this. There was no relationship in these three changes.

The bacteria which grew in the unsalted butter were not the kind that produce bad flavors, shown by the fact that the score of the butter did not decrease. In other words, the better

keeping quality of salted butter over unsalted butter held at warm temperatures due to the antiseptic property of the salt was entirely eliminated in this butter because the organisms which developed in the unsalted butter produced no off-flavors. Salt itself, exclusive of its beneficial antiseptic property, causes an increase in the rate of deterioration in butter which amounted to 2.33 per cent in score in this particular case. At -15°F ., deterioration was so slow that this difference was not marked.



Under ordinary conditions the increase in keeping quality due to the antiseptic property of the salt more than offsets the deterioration caused by the salt itself. When bacterial growth is checked by very cold temperatures it has been proven that the lightly salted butter keeps better than the heavily salted which falls into line with the results of this experiment.

SUMMARY

1. Salt, exclusive of its antiseptic property, hastened the deterioration of the butter.

2. When stored at -15°F. , unsalted butter kept as well as salted butter.

3. The bacteria in the unsalted butter decreased more rapidly at -15°F. , than they did in the salted butter and increased more rapidly at 58°F.

4. The acidity of the unsalted and the salted butter increased uniformly at -15°F. but at 58°F. the increase was greater in the unsalted butter.

5. Moisture was lost from the salted butter but not from the unsalted at -15°F.

6. Little if any relationship existed between the bacteria, the acidity, and the score in this butter.

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BLOWING RENOVATED BUTTER OIL AT PASTEUR- IZING TEMPERATURE¹

ROSCOE H. SHAW AND RAYMOND P. NORTON

*From the Research Laboratories of the Dairy Division, Bureau of Animal Industry,
U. S. Department of Agriculture, Washington*

INTRODUCTION

Among renovated-butter makers there is a rather widely prevailing opinion that the butter oil used as the basis for renovated butter can not be subjected to the pasteurizing temperature during the process of blowing without injuring the flavor, grain, and keeping quality of the finished product.

In the following investigation, which was designed to ascertain whether there is ground for this opinion, renovated butter was made under factory conditions from both pasteurized and unpasteurized butter oil. The unpasteurized butter oil was blown at the temperatures usually employed in the industry, while the other oil was blown at the pasteurizing temperature. All other conditions of manufacture were the same in both cases. The renovated butter was scored while fresh and after having been held in cold storage.

PRELIMINARY INVESTIGATIONS

Experiments were first conducted with a small laboratory apparatus, having a capacity of about 10 pounds, and modeled after the combined blower and emulsifier in use in some of the smaller factories. Later several runs were made with a larger equipment with a capacity of about 100 pounds. In this equipment the blowing tank was separate from the emulsifier, the latter being of the double dasher type. Briefly, the runs, were made as follows: The packing stock was melted and settled at a temperature below 110°F. The clear butter oil was divided

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into two parts. One part was blown at the pasteurizing temperature, about 140°F., and the other part serving as a check was blown at a temperature of between 110° and 120°F. In some cases the pasteurizing temperature was raised to 160°F. The subsequent operations of emulsifying with ripened skimmed milk, crystallizing, and working with a hand worker, were as nearly identical as it was possible to conduct them. The finished product was given to different consumers, each receiving a pasteurized and an unpasteurized sample marked in such a way as to be meaningless to them. They were requested to use the two samples as ordinary butter and to comment on them and state their preference.

Inasmuch as this work was preliminary, the detailed reports of the consumers will be omitted. In the majority of cases no differences could be detected by the consumer. In other cases some reported that the pasteurized sample possessed better quality, while others reporting on the same lot stated that the unpasteurized sample was the better. It was very evident that, if there was a difference in flavor between the pasteurized and unpasteurized samples, the difference was too small to be detected by the ordinary consumer.

INVESTIGATION AT FACTORY

Through the courtesy of the owners of one of the largest and best-equipped factories in the country, its facilities were placed at our disposal for the investigation. The factory is a thoroughly sanitary one, situated in a well-developed dairy region in the Central West.

PROCESS USED AT FACTORY

The packing stock is taken to the third floor, and after removal from containers is thrown into a large melting vat in the bottom of which are steam coils. One end of the vat is screened off, and in this screened-off section is a pump, constantly in operation during the melting process, conveying the melted mixture to a battery of settling tanks each having a capacity of 500 pounds.

The settling tanks are jacketed, the space between the jacket walls being filled with water which is heated with steam to maintain the proper temperature during the process of settling, which lasts from 6 to 10 hours. The clear butter oil is run from the settling tanks to the blowing tanks on the floor below. The blowing tanks also are jacketed, and have a capacity of 400 pounds of butter oil. The blowing is conducted at a temperature of from 110° to 120°F., about 15 hours being usually required for an average grade of packing stock. The air is washed and heated before coming into contact with the butter oil. The blown butter oil is passed over a continuous pasteurizer² held at 160°F., and is then ready to be emulsified. The emulsion is made in a circular tank provided with paddles or dashers revolving in opposite directions. The emulsion drops to the floor below into the crystallizing vat, and the crystals removed to the ripening room in trucks, each truck holding the contents of one blower. After ripening, the crystals are worked, salt added, and the finished product packed in cartons or tubs as may be demanded by the trade. It will be noted that this factory operates on what may be termed a unit system, the size of the unit being 500 pounds of finished renovated butter. From the time the packing stock is melted and placed in the settling tanks each unit is run by itself. For example, the contents of settling tank No. 1 go to blowing tank No. 1, and after being emulsified and crystallized is placed for ripening in truck No. 1. After ripening it is salted and worked by itself. This system enables a check to be held on each unit, and greatly simplified the investigational work.

PLAN OF INVESTIGATION

So far as the investigation is concerned, the packing stock for each day's run was of uniform quality. After melting, it was

² As a part of the regular procedure at this factory, the blown butter oil is passed over a continuous pasteurizer. Later in the paper the term "regular" is used to designate units which have been pasteurized in this way. This factory is one of few that subject the butter oil to the pasteurizing temperature at any stage of the process.

distributed among several settling tanks in conformity with the unit system of the factory. The units were allowed to settle at the same temperature for the same length of time and then run into the blowing tanks. Some of the units were blown at a temperature of from 110° to 120°F., others at 140°F., and still others at 160°F. In each case, the duration of blowing was governed entirely by the time required to "sweeten" the butter oil, a skilled operator being constantly on duty at the tanks during the blowing process. Some of the units blown at the lower temperature were subsequently passed over the continuous pasteurizer used for the regular product of the factory. From this point until it became a finished product, packed in pound cartons, each unit received, so far as it was possible to give it, identically the same treatment. The units blown at 110 to 120°F. are to be regarded as check units, and those blown at the higher temperatures as the pasteurized units.

The purpose in blowing some of the units at 160°F. was to learn the effect, upon the finished product, of a temperature considerably higher than is considered necessary for pasteurization.

Six 1-pound samples were taken from each unit. Three were immediately sent, in special containers by parcel post, to the scorers, and the other three sent in the same way to the cold-storage rooms.

COLD STORAGE

Since the scope of the investigation included the keeping quality of the finished product, the plan included the holding of the samples in cold storage for three weeks, this being considered as about the average time that renovated butter is kept in storage before it reaches the consumer. Some of the samples were kept in the cold storage rooms of a renovated-butter factory in Chicago, and the others in our own cold-storage rooms in Washington, the comparable samples being kept together in all cases. The temperatures of the storage rooms are not available, but it is considered that the samples were held under about the same conditions as is the average product from the time of its manufacture until consumed. At the end of three weeks the storage samples were scored.

SCORERS

The scorers selected for this work were men with years of experience in scoring renovated butter, and whose competency is unquestionable. The samples were sent to them labeled in such a way that they could not have known which had been pasteurized and which had not.

SYSTEM OF SCORING

The same system of scoring was used as with normal butter, with the exception that by agreement between the scorers, while

TABLE 1

Showing blowing temperatures, duration of blowing, and average scores of all units, when fresh and after storing

LOT NO.	UNIT NO.	TEMPERATURE BLOWN	HOURS BLOWN	AVERAGE SCORE FRESH*	AVERAGE SCORE STORED*	LOSS IN STORAGE
		<i>deg. F.</i>				
1	1	110-120†	15	87.83	86.33	1.50
1	2	Regular‡	15	89.50	86.00	3.50
1	3	140	2½	89.33	87.33	2.00
2	1	110-120†	14	88.33	86.17	2.16
2	2	160	2¾	88.50	87.83	0.67
2	3	140	4	88.67	87.00	1.67
2	4	Regular‡	15	89.17	87.50	1.67
3	1	160	4	87.67	87.00	0.67
3	2	140	4	88.50	87.00	1.50
3	3	Regular‡	15	88.00	86.83	1.17
4	1	140	4½	88.00	86.83	1.17
4	2	140	4½	88.67	87.50	1.17
4	3	140	4½	88.50	87.33	1.17
4	4	Regular‡	15	88.33	87.83	0.50
5	1	140	4	88.83	87.17	1.66
5	2	140	4	89.00	88.33	0.67
5	3	140	4	88.17	87.33	0.84
5	4	110-120†	15	88.67	88.00	0.67
5	5	Regular ‡	15	88.00	86.67	1.33

* Averages from scores of three scores.

† These units were not heated to the pasteurizing temperature at any stage of the process.

‡ These units were made in the regular way at this factory. They were blown at 110 to 120°F., and then run over a continuous pasteurizer.

TABLE 2
Showing scores by individual scorers

LOT NO.	UNIT NO.	TEMPERATURE BLOWN	SCORED BY MC'A.		SCORED BY L.		SCORED BY C.	
			Fresh	Stored	Fresh	Stored	Fresh	Stored
		<i>deg. F.</i>						
1	1	110-120*	88.50	86.50	88.00	88.50	87.00	84.00
1	2	Regular*	90.00	84.00	90.00	89.00	88.50	85.00
1	3	140	90.00	87.50	90.00	88.50	88.00	86.00
2	1	110-120*	89.00	83.50	88.00	89.00	88.00	86.00
2	2	160	88.50	88.00	89.00	88.50	88.00	87.00
2	3	140	88.50	87.50	89.50	89.50	88.00	84.00
2	4	Regular*	89.00	86.50	90.00	90.00	88.50	86.00
3	1	160	87.00	87.00	88.00	88.00	88.00	86.00
3	2	140	89.50	86.00	88.00	88.00	88.00	87.00
3	3	Regular*	87.50	86.00	89.50	88.50	87.00	86.00
4	1	140	88.00	87.00	88.00	88.50	88.00	85.00
4	2	140	88.00	87.70	89.50	89.00	88.50	86.00
4	3	140	87.00	86.00	90.00	89.00	88.50	87.00
4	4	Regular*	87.50	87.00	88.50	89.50	89.00	87.00
5	1	140	88.00	86.50	90.00	90.00	88.50	85.00
5	2	140	89.00	87.00	90.00	90.00	88.00	88.00
5	3	140	88.00	88.00	88.50	89.00	88.00	85.00
5	4	110-120*	88.00	87.00	88.50	88.00	89.00	89.00
5	5	Regular*	87.00	86.50	88.50	88.50	88.50	85.00

* See notes under table. 1

TABLE 3
Showing individual and average scores of units taken in groups

SCORERS	110-120°F.			REGULAR			140°F.			160°F.		
	Fresh	Stored	Loss	Fresh	Stored	Loss	Fresh	Stored	Loss	Fresh	Stored	Loss
McA.....	88.67	85.67	3.00	88.20	86.00	2.20	88.41	87.00	1.44	87.75	87.50	0.25
L.....	88.17	88.50	-0.33	89.30	89.10	0.20	89.28	89.06	0.22	88.50	88.25	0.25
C.....	88.00	86.33	1.67	88.30	85.80	2.50	88.17	85.89	2.28	88.00	86.50	1.50
Average....	88.28	86.83	1.45	88.90	86.97	1.93	88.93	87.32	1.61	88.08	87.42	0.66

Grand average of all units when fresh..... 88.55

Grand average of all units after three weeks in storage..... 87.14

Loss..... 1.41

100 is the perfect score for normal butter, 90 was considered as the highest score to be given renovated butter. In other words, a renovated butter scoring 90 is to be considered as perfect in flavor, grain, salt, color, and condition of package for that class of product.

DISCUSSION OF RESULTS

In studying the tables it should be borne in mind that fractions of scores mean very little. The human senses, even when highly trained, are not sufficiently sensitive to detect such small differences with exactness. Two experienced butter scorers working independently can not always be expected to agree within a point on an arbitrary scale. They can, however, be depended upon to detect very slight differences in flavor or grain in different samples of any given lot of butter.

In this investigation the comparable samples were subjected to the same conditions of transportation, etc. This is not true, however, of the samples sent to the different scorers. The work was done in May and June during a period of rather warm weather. The samples were sent through the open mails with, of course, no attempt at refrigeration. The samples received by scorers McA. and C. were sent from the Central West to Washington and to a place in New York State, while those received by L. were sent to Chicago, only a few miles from where they were manufactured. It will be evident that while the different samples comprising a given lot received by any one scorer are comparable, the corresponding samples received by the different scorers are not strictly so, since they were under different conditions of transit.

In examining the individual scores it will be observed that in eight instances the units were given perfect scores. In three of these cases the units had been made by the regular method of the factory, that is, by blowing the butter oil at from 110° to 120°F., and then passing it over a continuous pasteurizer, and in five cases the units had been made from butter oil blown at 140°F. Eighty-seven was the lowest score given any fresh unit. This was given in five cases; two regular units, one where the

butter oil had been blown at 110° to 120°F., one where it had been blown at 140°F., and one at 160°F. Three stored units were given perfect scores, two in which the butter oil had been blown at 140°F., and one regular. Eighty-three and a half and eighty-four were the lowest scores given stored units. These scores were given in four cases, two where the butter oil had been blown at 110° to 120°F., one at 140°F., and one regular. It will be seen from these individual scores that there is practically no difference between the units blown at the different temperatures. This is brought out even more clearly in table 3, which gives the average scores for the units taken in groups.

A striking point brought out in table 1 is the great reduction in time effected by blowing at the higher temperatures. It will be noted that it took but from two and one-half to four and one-half hours to "sweeten" the butter oil blown at the higher temperatures, while about fifteen hours were required to bring it to the same condition when blown at the lower temperature. This fact should be of value to renovated butter makers, inasmuch as it not only enables them to pasteurize their butter oil, but at the same time reduces by two-thirds or more the time of blowing, and should correspondingly reduce the cost of this phase of the renovating process. It may be of especial interest to the smaller plants which do not run continuously, since by employing the pasteurizing temperature the blowing can be completed in the day.

Somewhat closer attention is required from the operator when blowing at the higher temperatures, since the margin of time between the point when the butter oil "sweetens" and when it becomes "overblown" is shorter than with the low temperature. This should not, however, prove a serious objection.

SUMMARY

Renovated butter was made from a uniform grade of packing stock under factory conditions. The details of manufacture, except the blowing temperatures, were held as nearly alike as possible. Part was blown at the pasteurizing temperature, and

the rest at the usual temperature. Samples were scored while fresh, and after holding three weeks in cold storage. No differences were found that could be ascribed to the blowing temperatures.

From two and one-half to four and one-half hours were required to "sweeten" the butter oil at the pasteurizing temperature, while about fifteen hours were required to bring the butter oil blown at the usual temperature to the same condition, thus cutting down two-thirds of the operating time of this phase of the process.

CONCLUSIONS

The results of the investigation indicate that the butter oil may be blown at a temperature that will insure its pasteurization without impairing in any way the flavor, grain, or keeping quality of the finished product.

BUTTER SHRINKAGE

E. S. GUTHRIE

Ithaca, New York

Cornell University completed the storage of 100 tubs of butter on July 9, 1916. This butter was made in eight different churnings from sweet, pasteurized cream. The body was good, the moisture was nicely incorporated. All the butter was over-worked somewhat, which had a tendency to pretty complete incorporation of the water. The moisture and salt analysis were as follows for the eight churnings. .

CHURNING	DATE	MOISTURE	SALT
		<i>per cent</i>	<i>per cent</i>
I	June 23	15.4	3.1
II	June 24	14.9	2.5
III	June 25	15.5	2.5
IV	June 26	14.6	2.9
V	July 5	15.3	2.9
VI	July 1	15.1	2.8
VII	July 8	15.7	2.1
VIII	July 9	15.1	3.1

The tubs were paraffined. They were weighed just a few minutes before the butter was packed in them. Thus there was little shrinkage of the tub from the time that it was weighed until it was filled. The weighing was done on scales that weighed in terms of pounds and ounces. The same scales were used in all weighings.

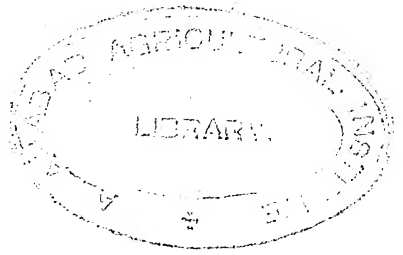
The butter was weighed on November 20, after being in cold storage for 134 days at 0° to -10°F. The shrinkage or increase in weight is noted in the following table.

Seventeen packages showed an increase in weight ranging from 0.5 ounce to 27.5 ounces. Eighty three tubs showed shrinkage which varied from 0.5 ounce to 15.5 ounces. The total shrinkage was 377.5 ounces. The total increase weight was

TUB NO.	DECREASE OR INCREASE	TUB NO.	DECREASE OR INCREASE	TUB NO.	DECREASE OR INCREASE	TUB NO.	DECREASE OR INCREASE
<i>Churning I</i>							
	<i>ounces</i>		<i>ounces</i>		<i>ounces</i>		<i>ounces</i>
1	- 3.5	5	+27.5	8	- 3.5	11	- 3.5
2	- 1.5	6	- 1.5	9	- 3.5	12	- 1.5
3	+10.5	7	+ 3.5	10	- 9.5	13	- 7.5
4	- 4.5						
<i>Churning II</i>							
14	-10.5	18	- 8.5	21	- 2.5	24	- 4.5
15	- 7.5	19	- 6.5	22	- 7.5	25	- 7.5
16	- 6.5	20	-13.5	23	- 7.5	26	- 6.5
17	- 7.5						
<i>Churning III</i>							
27	- 0.5	31	+ 3.5	35	+ 0.5	39	- 2.5
28	+ 3.5	32	- 1.5	36	- 4.5	40	+ 8.5
29	+ 1.5	33	- 2.5	37	- 2.5	41	- 3.5
30	- 2.5	34	- 0.5	38	- 0.5		
<i>Churning IV</i>							
42	- 0.5	46	- 3.5	49	+ 4.0	52	- 5.5
43	- 1.5	47	- 2.5	50	+ 1.5	53	- 2.5
44	+ 1.5	48	- 4.5	51	-15.5	54	+ 5.5
45	- 4.5						
<i>Churning V</i>							
55	- 1.5	59	- 1.5	63	- 8.5	66	- 3.5
56	- 3.5	60	+ 0.5	64	- 3.5	67	- 2.5
57	+ 9.5	61	- 1.5	65	- 0.5	68	- 1.5
58	- 5.5	62	- 4.5				
<i>Churning VI</i>							
69	- 3.5	73	- 5.5	76	- 1.5	79	- 2.5
70	- 8.5	74	- 7.5	77	- 3.5	80	+ 1.5
71	- 0.5	75	- 4.5	78	- 3.5	81	- 5.5
72	- 0.5						
<i>Churning VII</i>							
82	- 2.5	85	- 5.5	88	- 7.5	90	- 6.5
83	- 5.5	86	- 6.5	89	- 4.5	91	- 6.5
84	- 5.5	87	- 3.5				
<i>Churning VIII</i>							
92	- 5.5	95	- 4.5	97	- 6.5	99	- 1.5
93	- 9.5	96	- 5.5	98	- 3.5	100	+ 0.5
94	- 5.5						

85 ounces. The net shrinkage was 292.5 ounces or 18.28 pounds which is 0.1828 pound for tub or 0.29 per cent.

The writer cannot account for some of the extreme weights. It looks very much as though it was error in weighing. If the work is continued this summer, provision will be made for check weighing.



① AGE AT FIRST CALVING

G. C. WHITE

Storrs, Connecticut

The most desirable age for the first parturition with cows is a very important question. In a great many herds it is certain that the method of raising heifers is not such as to permit full development of their inherited powers of production. Prof. F. W. Woll in Research Bulletin No. 26 of the Wisconsin Experiment Station, and others, have shown positively that the large cows of any breed are capable of higher and more profitable production. It is the extra capacity that a large animal has that counts, providing they are equal in other respects.

For a good many years the belief was rife among breeders that it was necessary to have cows calve early in order to stamp upon them dairy qualities rather than tendencies for beef production. Some discovered from their own experience that this was erroneous, but these men were really in the minority. It was also commonly believed that heifers should not be allowed to become fat before calving and that they must get their nutrients for the most part from roughages. Dr. C. H. Eckles in Bulletin No. 135 of the Missouri Experiment Station shows that getting heifers fat affects the dairy qualities very little if at all and that those raised for the most part upon concentrates were equally as capable of consuming a dairy ration after calving as those raised on roughages, when each had become adjusted to the ration. Many Holstein breeders in preparing heifers for large records have learned to fear no injury to the dairy qualities by liberal feeding; with breeds where refinement of body is sought too much development before calving may, however, be detrimental.

The subject of this paper makes reference to the age at first calving. The age aside from the cost of raising heifers is in reality of little consequence at all. The thing of great importance is that they should be big, strong heifers and the procedure may

COW NO.	NAME	WEIGHT	SIRE	BORN	FIRST LACTATION				SECOND LACTATION			
					Age	Milk	Fat	Length	Age	Milk	Fat	Length
								days				days
1	Fay M 2d	1,400	Hubbard Netherland De Kol	10/31/05	2-3	7,803	273	340	3-2	9,683	312	365
2	De Kol Hubbard Pietertje	1,400	Hubbard Netherland De Kol	4/27/06	2-7	8,004	292	283	3-4	11,073	380	365
3	De Kol Hubbard Pietertje 2d	1,350	Minnie Hark Prince Korn-dyke	10/20/08	2-0	8,124	321	365	3-3	9,686	371	365
4	Fay De Kol Burke 4th	1,250	Minnie Hark Prince Korn-dyke	12/22/08	2-1	7,048	232	245	—	—	—	—
5	Fay M 2d Minnie Hark	1,350	Minnie Hark Prince Korn-dyke	1/ 5/09	1-11	7,059	226	365	—	—	—	—
6	Pietertje De Kol Burke 2d	1,500	Sir Inka De Kol Lilith	9/ 6/10	3-4	18,850	661	365	4-7	16,308	529	365
7	Storrs Pietertje	1,275	Sir Hubbard Pietertje	11/11/10	3-0	10,642	376	375	4-5	11,723	377	365
8	Minnie Fay Pietertje	1,350	Sir Hubbard Pietertje	12/16/10	3-6	17,020	525	365	4-9	20,823	607	365
9	Minnie Hubbard De Kol	1,175	Minnie Hark Pietertje Burke	2/ 8/12	2-4	8,420	315	365	4-0	6,663	252	265*
10	Fay Burke Pietertje	1,325	Minnie Hark Pietertje Burke	12/ 7/12	3-0	11,125	359	365	4-2	2/23/17†		
11	Minnie Fay De Kol	1,225	Minnie Hark Pietertje Burke	2/17/13	3-6	3,446	128	156*				
12	Dorinda Storrs De Kol	1,100	King Segis Inka Fayne	2/11/14	2-6	6,648	225	169†				

— Indicates incomplete gestation.

* Still milking.

† Still milking well in this lactation.

‡ Has milked over 70 pounds per day this period.

§ Lost quarter through injury.

** Still milking well in this lactation.

†† Still milking well in this lactation.

‡‡ Still milking well in this lactation.

§§ Still milking well in this lactation.

° Has milked over 10,000 pounds in 6 months.

AGE AT FIRST CALVING

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BLE 1

[illegible]

depend upon conditions. If concentrates are used liberally the rapid development will permit of earlier breeding. If the use of concentrates is limited the first calving period should be somewhat postponed.

In general practice, the dairy cows must pay the bills and this is a primary consideration. Roughages, so far as possible, must, therefore, be made use of, and heifers must calve so that returns will commence to come in. The aim of this paper is to present production records from the Connecticut Agricultural College Holstein herd which throw some light upon the question as to how to get the most capable animal.

The preceding tabulation gives the information concerning the registered cows at present in the herd that are in milk.

The table gives the name and sire of each one, the age at each calving and the amount of milk and fat produced in each lactation period, together with the length of such period. The production in excess of 365 days is not included, and the records during the period following incomplete gestations are omitted.

It will be noticed that the age of first calving varies from 1 year and 11 months to 3 years and 6 months. The ages that exceed thirty-six months have not purposely been arranged, but have resulted from failure to conceive promptly. The writer is not certain but that this has been a "blessing." Dr. Eckles in the bulletin above referred to pointed out that there seemed to be no advantage from having Holstein cows calve much later than thirty months, although he remarked that this would depend upon their stage of development. Our heifers are kept in thrifty condition and are fed skimmed milk with a grain supplement until six to eight months of age. After this, when not on pasture, they receive 3 to 6 pounds of grain, together with hay and silage daily to keep them growing well.

These cows are divided into two groups: those calving at thirty months or less and those calving at an age above thirty months. The average production of each group is given in tables 2 and 3.

Only ten are included in these tables because the other two have not completed a year or a lactation period. There are five in each group and the two remaining occur one in each division.

The average age of the early calvers is 2 years and 1.4 months and of the late calvers 3 years and 1 month, practically one year later. The production for the first period is 7691 pounds milk and 273 pounds fat in an average milking period of 356 days against 13,128 pounds milk and 443 pounds fat in 349 days



FIG. 1. FAY M. 2D MINNIE HARK

She shows here to her finest advantage. She is a little light in the middle and has a poorly developed fore udder. When taken she was heavy with fifth calf. She calved at 1 year 11 months. Best production 16,067 pounds milk and 495 pounds fat in her fourth lactation.

which is nearly double the early calvers. One of the late calvers milked only 283 days.

In the second period only two of the early calvers are included. Two others (nos. 4 and 5) aborted and another (no. 9) lost one-quarter due to an injury and her record was thrown out. Of the two included one is the best cow in this lot and the other is equal to the others. This year the average milk was 9684

pounds and the fat 342 pounds in 365 days. Only four of the late calvers have finished the second lactation and their average is 14,682 pounds of milk and 473 pounds of fat in 365 days. The fifth (no. 10) has recently freshened and has milked over 70 pounds in a day in her second period. The average age of



FIG. 2. PIETERJE DEKOL BURKE 2D

A large well developed cow weighing 1500 pounds. She weighed 1400 with her first calf and calved at 3 years 4 months. She produced 18,850 pounds of milk and 661 pounds of fat with her first calf which placed her fifth at the time in her class of world's records. She is feminine and a striking Holstein type.

freshening was 3 years 2.5 months and 4 years 5 months respectively for the two groups.

In the third period four of the early calvers have completed a record. Their average is 13,552 pounds of milk and 467 pounds of fat in 360 days. The average age of freshening is 4 years 9.5 months. Their production for this year is approximately equal to the first year of the late calvers. Their total average

production for three lactations is only 3000 pounds greater than the total average production of the late calvers in two lactations. Their age at the third calving is 4 years 9.5 months against 4 years and 5 months, the average age at 2nd calving of the late calvers. Only one of the late calvers (no. 2) has finished the third lactation period; she produced 14,236 pounds of milk and

TABLE 2

Early calvers. Cows calving thirty months or under.

COW NO.	AGE FIRST CALVING	FIRST PERIOD			SECOND PERIOD			THIRD PERIOD		
		Milk	Fat	Days	Milk	Fat	Days	Milk	Fat	Days
1	2-3	7,803	273	340	9,683	312	365	10,882	350	365
3	2-0	8,124	321	365	9,686	371	365	18,206	718	365
4	2-1	7,048	232	345	—	—	—	12,655	434	343
5	1-11	7,059	226	365	—	—	—	12,467	366	365
9	2-4	8,420	315	365	—	—	—			
Total.....	10-7	38,454	1,367	1,780	19,369	683	730	54,210	1,868	1,438
Average.....	2-1½	7,691	273	356	9,684	342	365	13,552	467	360

TABLE 3

Late calvers. Cows calving at age over thirty months

COW NO.	AGE FIRST CALVING	FIRST PERIOD			SECOND PERIOD			THIRD PERIOD		
		Milk	Fat	Days	Milk	Fat	Days	Milk	Fat	Days
2	2-7	8,004	292	283	11,073	380	365	14,236	520	365
6	3-4	18,850	661	365	16,308	529	365			
7	3-0	10,642	376	365	11,723	377	365			
8	3-6	17,020	525	365	20,823	607	365			
10	3-0	11,125	359	365						
Total.....	15-5	65,641	2,213	1,743	59,927	1,893	1,460	14,236	520	365
Average.....	3-1	13,128	443	349	14,682	473	365	14,236	520	365

520 pounds of fat in 365 days. Number 6 will produce around 12,000 pounds of milk, no. 7 about the same and no. 8 is starting off at better than a 15,000 pound rate. In her fourth lactation period no. 2 produced 23,176 pounds of milk.

Just how much individuality, breeding, and management have to do with these yields it is impossible to say. All have

descended from the same family lines in the herd and two of the sires, Sir Hubbard Pietertje and Minnie Hark Pietertje Burke are out of cows that were bred in the herd. Among the late calvers Minnie Fay De Kol has not completed a record, but she is the only one to be a low producer. Due to an ill-formed udder she is considered a failure and will be discarded, but she is not lacking in feminine qualities and is a good sized cow for her age. Number 12 is the only one in the early calvers that has not completed a record. She calved at 2 years 6 months and is an unusually good heifer that would be good for 18,000 if she had the scale and development possessed by the late calvers in their first period. As it is, she should come close to 12,000 pounds of milk. As to management, there is no doubt but that the herd has been under somewhat more intensive working conditions for the past five years, but numbers 1, 3, 4 and 5 of the early calvers have reached their limit while in the writer's opinion nos. 6 and 10 will join nos. 2 and 8 (all late calvers) in the 20,000 pounds division. Whether no. 7 will do this is problematical. Number 12 of the early calvers will be expected to do so, but to insure proper development she will be given a long dry period this year.

Only one cow among the late calvers would be criticised for lack of refinement, or femininity. This one, no. 8, has a steerish head. All of them appeared somewhat lacking in dairy form until they became advanced in the gestation period, and especially after calving they rapidly assumed a dairy conformation. Number 6 the largest one in the lot is typically Holstein and decidedly feminine. Numbers 3, 4, 5 and 9 of the early calvers, while good cows are all somewhat smaller than the others and lack in that splendid size and capacity shown early by the other group.

For various reasons it is becoming more and more important for dairymen to get the most efficient production from their herds. In herds of doubtful dairy qualities, there is good reason to have cows calve early to find as soon as possible if they are worth having in the herd. In a herd where dairy qualities are of medium to high order, more attention should be given to the

full development of the heifers in size and capacity for efficient and profitable production.

Would it not be well for other experiment stations to present any data they have along this line through the columns of this organ?

REPORT OF COMMITTEE ON CHANGE OF NAME

At the Springfield meeting of the Official Dairy Instructors' Association, exception was taken to the name of the Association because the word "Official" suggested police activities and the word "Instructor" seemed to limit the membership unduly.

After some discussion the following action was taken:

It was moved and seconded that the change of the name of the Association be left to the President, Secretary, and Professor Harding, but before a name be adopted a vote of the membership be made.

The first step of the Committee was to solicit suggestions from various members of the Society as to what seemed most desirable in the way of a Society name. These suggestions were then submitted to the entire membership with the request that the first, second, and third choice of each member be returned to the committee upon an enclosed postal card. The date set for the closing of the ballot was March 15. The results of this ballot are given below:

Relation of votes on future name of Official Dairy Instructors' Association

	FIRST	SECOND	THIRD	VALUE
American Dairy Instructors' Association.....	11	12	8	19 $\frac{2}{3}$
American Association of Dairy Instructors.....	10	4	9	15
Association of American Dairy Instructors.....	0	4	4	3 $\frac{1}{3}$
Society of American Dairy Instructors.....	7	4	7	12 $\frac{1}{3}$
American Society of Dairy Instructors.....	2	11	11	11 $\frac{1}{3}$
American Association for the Promotion of Dairy Research and Instruction.....	7	10	17	17 $\frac{2}{3}$
Society of American Industry.....	1	4	2	3 $\frac{1}{3}$
American Society of Dairy Industry.....	9	16	3	18
American Association of Dairymen.....	0	7	3	4 $\frac{1}{3}$
American Dairy Science Association.....	32	10	14	41 $\frac{2}{3}$
Scattering.....	8	2	2	9 $\frac{2}{3}$

It will be noted from the above table that the "American Dairy Science Association" was by far the predominating first

choice of the members voting. In attempting to give proper valuation to the second and third choice of each member, it seemed best to consider that two second and three third choices had the same weight as the one first choice. The table, accordingly, shows the values of the vote computed upon this basis. It will be noted, that upon this basis, also, the vote for the "American Dairy Science Association" name is very much in the lead.

As the result of the action of the Society at its last meeting, and as the result of the vote which has just been taken, the "Official Dairy Instructors' Association" has now become the "American Dairy Science Association."

Respectfully submitted,

(Signed) H. A. HARDING.

Approved:

W. A. STOCKING, *President*.

M. MORTENSEN, *Secretary*.

① REPORT OF THE COMMITTEE ON METHODS OF
CONDUCTING THE STUDENTS' NATIONAL
CONTEST IN JUDGING DAIRY CATTLE

HELMER RABILD, H. H. WING, H. H. KILDEE, J. A. McLEAN, E. G.
WOODWARD AND WILLIAM REGAN

The Students' National Contest in Judging Dairy Cattle has been held each year since 1908, with the exception of the year 1915, when there was no National Dairy Show. Beginning with 1908 and ending with 1916, 97 teams and 2 individuals, making a total of 293 students, representing 25 agricultural colleges, have participated in the various contests. The following table shows which colleges have competed in each of the contests.

Iowa, Missouri, Nebraska, New York, and Ohio have competed in all the contests.

Since the contest was first established, the various dairy breeders' associations whose cattle were judged, together with Hoard's Dairyman, the National Dairy Show Association, and the J. B. Ford Company, have demonstrated their willingness to promote the contest by awarding trophies in the form of silver cups to the winning teams.

The various dairy breeders' associations have given cups to the teams that have won the highest scores in judging their respective breeds. The National Dairy Show Association and Hoard's Dairyman award their cups to the sweepstakes teams. The Wyandotte cup is offered by the J. B. Ford Company, manufactures of the Wyandotte Dairyman's Cleaner and Cleanser, to the team receiving the second highest total score in judging all classes.

A sweepstakes prize of \$50 was awarded by the National Dairy Show in 1908, 1909, and 1910 to the man who received the highest individual score in judging all classes. The William Howard Taft cup, offered in 1911, was awarded to the man who made the highest individual score in judging all classes. In 1912

Colleges participating in judging contests

1908	1909	1910	1911	1912	1913	1914	1916	NUMBER OF CONTESTS PARTICI- PATED IN BEFORE 1917
Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	Iowa	8
Mo.	Mo.	Mo.	Mo.	Mo.	Mo.	Mo.	Mo.	8
Neb.	Neb.	Neb.	Neb.	Neb.	Neb.	Neb.	Neb.	8
N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	N. Y.	8
Ohio	Ohio	Ohio	Ohio	Ohio	Ohio	Ohio	Ohio	8
Kan.			Kan.	Kan.	Kan.	Kan.	Kan.	6
		Ky.	Ky.	Ky.	Ky.	Ky.	Ky.	5
S. Dak.			S. Dak.	S. Dak.	S. Dak.	S. Dak.	S. Dak.	6
	Penn.			Penn.	Penn.	Penn.	Penn.	5
		N. H.		N. H.	N. H.	N. H.	N. H.	5
			Del.	Del.	Del.	Del.	Del.	5
			Md.	Md.	Md.	Md.	Md.	5
				Mass.	Mass.	Mass.	Mass.	4
					Maine	Maine	Maine	3
Minn.	Minn.	(Minn.)*						2
				Mich.	Mich.			2
Texas					Va.			1
						Ark.		1
						Ore.		1
							Conn.	1
							N. J.	1
							N. C.	1
							R. I.	1
							Vt.	1
9	7	7	10	14	16	16	18	97

* One member of team withdrew from team, and the remaining two competed as individuals.

and 1913 the sweepstakes prizes consisted of scholarships, given by the De Laval Separator Company and the Blue Valley Creamery Company to the two best men. In each of the two years 1914 and 1916 the National Dairy Show awarded five gold medals to the five highest men in judging all breeds, and the De Laval scholarship went to the highest. In 1914 and 1916 the Iowa Dairy Separator scholarship was awarded to the institution sending the sweepstakes team.

The following table indicates in detail the trophies offered each year, and the winners of these trophies:

Winners of trophies

	1908	1909	1910	1911	1912	1913	1914	1916
National Dairy Show cup.....	Iowa	Nebr.	N. Y.	Ky.	Nebr.	Mo.	Ohio	Nebr.
Hoard's Dairyman cup	Iowa	Nebr.	N. Y.	Ky.	Nebr.	Mo.	Ohio	Nebr.
Jersey cup.....	Nebr.	N. Y.	N. Y.	Md.	Mo.	Iowa	Ohio	Mass.
Guernsey cup.....	Iowa	Minn.	N. Y.	Ky.	Mass.	Pa.	Ark.	Kan.
Holstein cup.....	N. Y.	Nebr.	Ohio	Ky.	Neb.	Mo.	Maine	Nebr.
Ayrshire cup.....		Ohio					Kan.	N. H.
Dutch Belted cup....	Iowa	Mo.						
President Taft cup....				S. Dak. Russell Jensen,				
Wyandotte cup.....							Kan.	Mass.

National Dairy Show sweepstakes prize:

1908.....F. D. Hawk, Iowa
 1909.....Will Forbes, Nebraska
 1910.....T. B. McNatt, Missouri

Gold medals:

1914.....Rob. Wylie, Ohio; P. E. Richards, Kentucky; C. E. Wylie, Ohio; V. F. Stuewe, Kansas; and G. G. Davis, Missouri.
 1916.....H. H. Hawes, Rhode Island; W. L. Henderson, Iowa; F. W. Fitch, New Hampshire; E. M. Harmon, Missouri; and C. R. Snyder, Nebraska.

A total of 48 cups have been offered, of which the following colleges have won two or more:

Nebraska.....10	Missouri..... 5	Kansas..... 3
New York..... 6	Ohio..... 5	Massachusetts..... 3
Iowa..... 5	Kentucky..... 4	

Beginning with the 1910 contest, the sum of \$8400 has been awarded to students who competed in the contest, or to colleges represented in the contest to be reawarded to worthy students of those institutions. Of this sum, \$5800 has been paid or is in process of payment, while \$1000 has reverted to the donors. The sum of \$1600 remains to be paid to the four students who were winners in the 1916 contest.

This prize money has enabled eleven students to complete each one year of postgraduate work in dairying, three students to begin their postgraduate courses during the present school year, and four others to begin their postgraduate courses upon graduation. Another student completed one half-year of advanced work in dairying.

The following associations and companies have donated, scholarships:

1. Holstein-Friesian Association of America.
2. American Jersey Cattle Club.
3. Blue Valley Creamery Company, of Chicago, Illinois manufacturers of Blue Valley butter.
4. De Laval Separator Company, of Chicago, Illinois, manufacturers of the De Laval cream separator.
5. Associated Manufacturers Company, of Waterloo, Iowa, manufacturers of the Iowa dairy separator.

The disposition of the scholarship money is indicated in detail in the following outline.

Mr. T. B. McNatt, since completing his course, has been connected with private dairy interests in and near Memphis, Tennessee.

Mr. Ivan McKellip is employed in dairy-extension work in Ohio by the Dairy Division, U. S. Department of Agriculture, in coöperation with the Ohio State University.

Mr. Karl B. Musser is employed in dairy-extension work in Connecticut, by the Dairy Division of the U. S. Department of Agriculture, in coöperation with the Storrs Agricultural College.

Mr. A. C. Stanton is an instructor in dairy husbandry at the Maryland Agricultural College.

Mr. Russell Jensen conducts the Progressive Dairy Depot at Watertown, South Dakota. Mr. Jensen is a dealer in milk, cream, butter, and wholesale ice cream.

Mr. C. L. Burlingham recently resigned from a position with the Dairy Division, U. S. Department of Agriculture, to become associate editor of the *Hoard's Dairyman*, Fort Atkinson, Wisconsin.

Mr. Omar I. Oshel was employed by the Dairy Division, U. S.

Outline of scholarships

YEAR	SCHOLARSHIP	WINNER	STATE	CLASS	POST-GRADUATE COURSE TAKEN AT	YEAR OF POST- GRADUATE COURSE
1910	Holstein	T. B. McNatt	Mo.	1911	Cornell	1911-12
	Jersey	Ivan McKellip	Nebr.	1911	Cornell	1911-12
1911	Holstein	Karl B. Musser	Kan.	1912	Missouri	1912-13
	Jersey	A. C. Stanton	Md.	1912	Missouri	1912-13
	Blue Valley	Russell Jensen	S. Dak.	1912	Missouri	1912-13
1912	Holstein	C. L. Burlingham	Iowa	1913	Missouri	1913-14
	Jersey	Omar I. Oshel	Kan.	1914	Missouri	1915-15
	Blue Valley	S. H. Whisenand	Nebr.	1915	Died†	
	De Laval	H. C. Heaten	Mo.	1914	Forfeited†	
1913	Holstein	L. W. Wing*	Mo.	1915	Cornell	1915-16
	Jersey	W. W. Swett	N. H.	1915	Missouri	1915-16
	Blue Valley	W. A. Rhea	Mo.	1915	Cornell	1915-16
	De Laval	L. G. Mulholland	Del.	1916	Wisconsin	1916-17
1914	Holstein	C. L. Blackman	Maine	1916	Iowa	1916-17
	Jersey	M. H. Keeney	Pa.	1915	Missouri	1916-17
	De Laval	Robert Wylie	Ohio	1915	Missouri	1915-16
	Iowa Dy. Sep.	C. Elmer Wylie	Ohio	1915	Missouri	1915-16
1916	Holstein	W. F. Roberts	Nebr.			
	Jersey	C. H. Clough	Mass.			
	De Laval	H. H. Hawes	R. I.			
	Iowa Dy. Sep.	Nebraska team	Nebr.			

* Surrendered half of scholarship when he discontinued work at Cornell at the end of the first semester.

† The Blue Valley and De Laval scholarships offered in 1912 were not used by the winners and the money reverted to the donors.

Department of Agriculture, in coöperation with Purdue University to do extension work in dairying in Indiana. Mr. Oshel resigned from this position August 1, 1916, to begin work on his own farm in Kansas.

Mr. W. W. Swett is an instructor in dairying at the University of Missouri.

Mr. W. A. Rhea is an instructor in dairying at the College of Agriculture of the West Virginia University.

Mr. L. G. Mulholland, Mr. C. L. Blackman, and Mr. M. H. Keeney are at present pursuing their postgraduate studies.

Mr. Robert Wylie is an instructor in dairying at the Iowa State College.

Mr. C. Elmer Wylie is an instructor in dairying at the University of Tennessee.

As the contest has grown in popularity and influence there has been a corresponding change in the methods of conducting it. Some of these changes have been developed to meet new conditions, and others have been developed to better meet the conditions that have existed in all the contests. Your committee on method of conducting the judging contest has been very grateful to receive criticisms and suggestions from so large a number of instructors in animal and dairy husbandry in the agricultural colleges. While many of your suggestions have been incorporated into the rules in some form, there may be some among you who find that their ideas have not been incorporated. Your committee has given very thorough consideration to every letter it has received, and the ideas expressed have been incorporated into the proposed rules so far as possible. In cases in which it was found impossible to use the idea, an attempt has been made to explain to the writer the reason why it was not incorporated. That the contest has greatly improved we believe to be beyond question, yet we realize that it is still far from perfect, and we earnestly solicit your continued coöperation and mutual helpfulness to promote the contest from year to year.

In 1908 there was one official judge for each breed. It was the duty of this judge to make the official placing of each class in his own breed, and to grade the contestants' placings and reasons for placing. When a class of animals was brought into the ring the judge looked it over, made his decision regarding the animals, and then retired to the judging room. After examining the class the contestants reported to the judge one by one, to be graded. The reasons were given orally. The animals to be judged were selected by the general superintendent of the livestock department.

In 1909 the rules provided that while the animals were ex-

amined by the contestants the animals should be walked at least three minutes so as to enable the contestants to see them in motion. The animals were selected by the superintendent of the contest instead of by the superintendent of the livestock department.

In 1910 the judging committee consisted of three men, who made the official placing of all classes and graded the contestants' placings and reasons. These judges scored the animals in each class, using the score card prescribed by the breeders' association of each breed. The official placing of a class was determined by the averages of the scores for each animal. After a group of contestants had examined a class of animals they recorded the placings and made notes regarding the animals. After examining two groups they were conducted into a room where they wrote their reasons for placing.

The placing of the animals was graded by the judges' clerk, according to a table prepared before the contest. This table provided a cut of ten points for each place that the animal was out of place. In grading reasons the clerk read the contestants' papers to the three judges. The average of the three grades made by the judges was assigned to the contestant as his grade on reasons.

In all contests previous to 1911, ties between contestants, if they existed, were broken by finding who had obtained the highest rating in judging bulls. The rules since 1911 have provided that ties should be broken by finding who had obtained the highest rating in judging cows.

The deduction for placing an animal one place too low or one place too high was made 15 points instead of 10 points.

The rules governing the 1912 judging contest were not materially different from those governing the contest in 1911.

In 1913, the judging committee consisted of one man from each institution having a team in the contest. This man was the coach of the team. The committee collectively decided the official placing of the animals in each class, and graded the contestants' reasons for placing. One of the reasons for changing the composition of the judging committee was the great difficulty

in securing a committee of three men upon whom all could agree. Even when this had been accomplished it was necessary to make substitutions because some of the men selected had already been engaged as judges of the Show or because they refused to serve. It was also believed by many of the instructors that while the expert judges were well qualified to place the animals properly, yet they were not in all cases well qualified to grade the students' reasons. The chief reason, however, was the belief that with the instructors placing the animals and grading the reasons, the judging of dairy cattle would be materially standardized in the agricultural colleges.

On the basis of the experience in 1913 it was found advisable to modify the rules for 1914 so as to provide that the committee of judges should be divided into four groups, each group to hear and grade all the reasons of two classes, one of cows and one of bulls, both of the same breed. The rules were further amended to make a cut of 5 to 10 points instead of 15 for switching a pair of animals within a class that had been agreed by the judging committee were close. Whether 5 or 10 points were cut depended upon the degree of the closeness.

Early in 1915 a very thorough analysis was made of the methods and results of the 1914 contest. The main difficulty of this contest as learned in the analysis, was that there was little uniformity in the reasons for placing and that on account of the variation it was practically impossible for the judges to give a just rating on the papers. It was at first believed that in future contests the students should be asked to follow an outline in writing their reasons; however, we realized the extreme difficulty in arriving at an agreement as to what form this outline should take. Your committee therefore suggested that the instructors should encourage their students to limit their reasons to the more important points in judging dairy cattle, and to make the reasons comparative rather than descriptive. In the contest we have just held, the students were provided with a single sheet of paper on which to write the reasons for each group of four animals.

The rules for 1916 were further modified so^{as} to make addi-

tional deductions for incorrectly placing a class of animals in which two animals were widely separated. The rules for 1914 provided that the student should be cut 5 to 10 points for switching a close pair. In the 1916 contest we went one step further, and provided that additional cuts should be made for incorrectly placing a class of animals in which there is considerable variation. In order to avoid unnecessary complications we now make no distinction between close and very close pairs.

We have now traced the development of the judging contest in its various phases from the year it was first established to the present time. Whereas the first contest was a competition between nine teams, at which five trophies and a sweepstakes prize of \$50 were offered, the 1916 contest was a competition between 18 teams, at which 7 team trophies, 5 gold medals, and \$1600 in scholarship money was offered.

In the 1914 contest it became apparent to the management of the contest that there is a practical limit to the number of teams which can be handled without interference with the opportunity of the individual students to see and examine the animals. With 16 teams in the contest there is considerable difficulty in giving each student proper opportunity.

This fact was again demonstrated with the 18 teams in the 1916 contest. In the 1916 contest more than one-third of the agricultural colleges participated. With the growing interest in dairy-cattle judging, it was thought that in the near future several of the secondary schools would apply for participation in the contest. In order to prevent the contest from becoming unwieldy, it was decided to amend the eligibility clause for future contests to read as follows:

ELIGIBILITY OF CONTESTANTS

Any student of an agricultural college, who is regularly matriculated in a four-years course in agriculture or dairying, and has taken not less than twelve weeks undergraduate work in that institution during the calendar year in which the show is held, who has never taken part in any dairy-cattle judging contest of

a national or international character, nor in more than one inter-collegiate contest, and that within the same calendar year, who has never acted as an official judge of cattle at a fair or show, and who has at no time served in the capacity of a teacher of animal husbandry or dairy husbandry in an agricultural college or secondary school, may enter as a member of a team to represent the college in which he is matriculated.

Immediately preceding the 1916 contest, the question arose as to whether or not the teams which had participated in the dairy-cattle judging contest at Waterloo, Iowa, were eligible, under the rules then in force, to participate in the national contest at the dairy show. At a meeting of the coaches held on the evening of October 12, it was decided that those students were eligible for the national contest.

An exhaustive analysis has been made of the 1916 contest, embracing a study of the system used in rating the students on written reasons, and of the different methods used in all past contests for determining the contest placing as compared with the official dairy-show placing. This analysis will be placed in the hands of the colleges which have participated in the contest, together with an outline of a proposed modification of the system for computing the ratings.

REPORT OF COMMITTEE ON INTERNATIONAL DAIRY CONGRESS

PRESENTED AT THE ANNUAL MEETING AT SPRINGFIELD,
MASSACHUSETTS, OCTOBER 17, 1916

Committee: Fred Rasmussen, *Chairman*; B. H. Rawl, R. S. Breed, O. F. Hunziker,
M. Mortensen

At the meeting of this Association held October 27, 1914, Prof. O. F. Hunziker, former Chairman of the Committee on International Dairy Congress, made a report to this Association. Information was presented relating to the proper procedure for securing the Congress for the United States. Report of joint meetings of the Committee and the National Dairy Council was presented. Efforts were made to obtain the financial and moral support of the various National dairy associations which met with failure.

Since the report of this Committee, the Sixth International Dairy Congress has been held in Berne, Switzerland. At this Congress there were over 1000 delegates present, coming from all parts of the world. It was considered the most successful Congress ever held. This great country, in which the value of the dairy products exceed \$800,000,000 yearly, had one official delegate, sent by the State of New York. To members of this Association, it is needless to go into detail in regard to the great advantage to the teachers and scientists of attending this Congress, also the great advantage it would be to the dairy interests of this country to have the Congress held in United States.

The Seventh International Dairy Congress was to have been held in Denmark in 1917, but owing to the world war, the time for holding the Congress has been indefinitely postponed. It is, therefore, impossible at this time to make efforts to get the Congress to this country at a definite time.

Back of this International Dairy Congress is The International Dairy Federation. In 1903, when this Federation

was formed, Major Alvord was appointed a member of the Permanent Bureau of the International Dairy Federation. Soon afterward he appointed a committee of sixteen members to represent the dairy interests of United States. The membership of this Committee has not been kept up to a working basis. Your Committee, therefore, recommends that this Association request the present member of the Permanent Bureau for the United States, Chief B. H. Rawl, to revive the Committee of the International Dairy Federation with a view to creating an organization and sentiment for getting the International Dairy Congress to the United States and to get the support of the United States Congress so that the invitations to the International Dairy Congress will be sent through diplomatic channels, thus giving the Congress the same official standing it has had in all other countries.

REPORT OF COMMITTEE ON THE USE OF ALKALIES IN BUTTERMAKING

PRESENTED AT THE ANNUAL MEETING AT CHICAGO, ILLINOIS,
OCTOBER, 1912

Committee: J. H. Frandsen, *Chairman*, M. Mortensen, Geo. Hines, F. W. Bouska

That your committee might quickly gather as much preliminary information as possible regarding "The Use of Alkalies in Buttermaking" a question blank was prepared by the Chairman and sent to many of the leading dairymen in College and practical work. The principal questions asked were substantially as follows:

1. What do you consider the principal reasons for the use of alkalies?
2. (a) What alkalies do you find most commonly used by the creameries in your State?
(b) If alkalies are to be used by the creameries, which would you consider most desirable? Why?
3. To what extent do you believe alkalies are now used in the creameries?
4. To what extent do you believe it possible to improve the quality of the butter from bad cream by the use of alkali?
(a) To what extent is the producer benefited or injured by this practice?
(b) To what extent is the manufacturer benefited or injured by this practice?
(c) To what extent is the consumer benefited or injured by this practice?
5. To what extent do you believe the healthfulness or wholesomeness of butter to be affected?
Please give any physical, chemical or bacteriological data that you may have available showing difference in butter made from cream to which alkali has been added.
6. Do you consider the practice of adding alkalies of any kind to the cream as injurious to the health of the consumer?
7. What do you consider would be the moral effect of permitting the general use of alkali in buttermaking?

Briefly summarizing the following answers were given to the questions asked:

1. What do you consider the principal reasons for the use of alkalies?

Answer: When sour cream is used!

(1) "For sake of uniformity of products." (2) "To develop a better flavor." (3) "To reduce acidity." (4) "To eliminate the characteristic scorch-flavor produced by pasteurizing sour cream." (5) "Prevent heavy loss of butter-fat in buttermilk." (6) "To improve flavor and keeping qualities of butter made from sour cream." (7) "To make possible the pasteurization of high acid cream without the metallic or scorched flavors."

2. (a) What alkalies do you find most commonly used by the creameries of your State?

Answer: (1) Lime (from every report). (2) Soda (reported by one). (3) Lime and sugar.

(b) If alkalies are to be used by the creameries which would you consider most desirable? Why?

Answer: (1) "Lime—because least objectionable to consuming public." (2) "Lime—because used in such small quantities it would not be injurious to the health of consumer." (3) "Lime—because less soluble in water, and less apt to remain in finished product." (4) "Free from undesirable flavors or odors." (5) "Lime—because it is cheap." (6) "Natural constituent of milk ash."

3. To what extent do you believe alkalies are now used in the creameries?

Answer: (1) "Nearly every creamery doing a shipping business and in some local creameries." (2) "In practically all centralizers." (3) (In Oregon) probably 10 per cent or more—while many creamerymen know nothing of the process." (4) "Do not know." (5) "Used by large creameries but not by small coöperative creameries" (Indiana). (6) "Cannot say—but perhaps by but few creameries in the State" (Iowa).

4. To what extent do you believe it possible to improve the quality of butter from bad cream by the use of alkali?

Answer: (1) "When used in combination with proper methods of pasteurization and with starter the quality of butter may improve 4 or 5 points." (2) "If really poor cream is used quality may improve from 1 to 3 per cent. In clean flavored cream—no improvement." (3) "Two points." (4) "Don't know." (5) "At least one grade."

(6) "One to three points—the latter only in case of storage." (Just the reverse.)

4. (a) To what extent is the producer benefited or injured by this practice?

Answer: (1) "Producer allowed to give cream less care." (2) "Benefited to extent that buttermaker takes cream that otherwise would have to be rejected. Injured by being led to believe no particular attention need be paid to care of cream." (3) "Producer not benefited." (4) "Some coöperative creameries are not compelled to use it and it must be a drawback to producer because he will not realize the importance of caring for his cream." (5) "Not benefited—but induced to employ shiftless methods a little longer." (6) "Benefited slightly by price paid for fat (1 cent per pound)." (7) "Indirectly injured because cream may get too old so as to sell 2 cents per pound less." (8) "Producer of low grade cream and small producer with poor market facilities benefited to extent of 2 cents per pound at expense of high producer with good market."

(b) To what extent is manufacturer benefited or injured?

Answer: (1) "Benefited by being able to produce a fair piece of butter out of old cream. Injured because it (a) militates against a good cream, (b) holds down prices, (c) retards Dairy development, (d) aids sale of butter substitutes. Injury greater than benefit." (2) "Manufacturer injured morally, benefited financially." (3) "Benefited by improving quality of butter—less cost of neutralization." (4) "Benefited by being able to make first grade butter from second grade cream."

4. (c) To what extent is consumer benefited or injured by this practice?

Answer: (1) "Consumer will be able to get only medium quality as strictly first class butter can not be made. He will be financially benefited because he will have to depend more on substitutes which are less expensive." (2) "Consumer not benefited." (3) "Neither benefited nor injured." (4) "No harm comes from neutralizer itself but it is the means of covering up filthy practices."

5. To what extent do you believe the healthfulness or wholesomeness of butter will be affected?

Answer: (1) "No effect from alkali but effect from toxic ferments in poor cream probable." (2) "No effect from alkali." (3) "No effect from alkali known." (4) "Very little if any." (5) "No direct result but only medium quality butter can be produced." (6) "Lime per-

mits higher temperature of pasteurization hence more killed germs—a better flavor, and but slight trace of lime found by chemist.” (7) “None by neutralizer.”

6. Do you consider the practice of adding alkalies of any kind to the cream as injurious to the health of the consumer?

Answer: (1) “No, not with lime anyway.” (2) “No, except from condition of cream which made the use of alkali necessary.” (3) “No” (no data available). (4) “Might be injurious, especially for buttermilk.” (5) “Not with lime but would be if harmful alkali is used.” (6) “Only indirectly.”

7. What do you consider the moral effect of permitting the general use of alkali in buttermaking?

Answer: (1) “The same, but in less degree, as the sale of renovated butter as creamery butter.” (2) “Economic result would be a failure to have cream quality raised.” (3) “Bad, but justifiable as a temporary expedient.” (4) “Tendency to encourage lax methods, and arouse suspicion of the consumer.” (5) “Make producer less careful and make less really first class butter.”

To the question asking for available physical, chemical and bacteriological data the universal answer was “no data available.”

Because practically all seemed to realize that there was practically no actual data of any importance on this subject, it was thought best to inaugurate at least such work as would give us some general information on this subject. Accordingly about twenty experiments were started in our laboratory. Some of the butter was made from good cream, some from cream only fair, and some from cream about as bad as ever greased the vats of the poorest centralized plant. Each batch of cream was divided into 2, 3 or 4 parts. Part of the cream was churned raw, part was neutralized to about 0.3 per cent acid before being pasteurized. The different batches of cream were carefully scored by the assistants of the dairy department and by the writer. Some of the butter from unneutralized cream scored practically as high as that made from the treated cream. This was particularly true in the cases where the cream was of good flavor and not very sour. However in the most of the butter made from the very sour, bad flavored cream the score was

nearly always from 2 to 5 points higher than that of the butter made from the untreated cream.

Regarding the texture of the butter, the writer could not note any particular difference except in one or two cases where the cream had been treated with alkali to a point where it was practically neutral in its reaction. In this case the butter showed a very poor body and texture and was distinctly greasy. These samples also had a slightly bitter flavor.

CHEMICAL RESULTS

Chemical analyses were made of each sample of butter with a view of ascertaining any possible difference in chemical composition. The chemical analysis showed considerable variation and no particular importance can be attached to the few preliminary results available at this time except as a general indication of certain tendencies.

The average amount of calcium oxide found in the butter made from the treated cream was 0.075 per cent. Practically all the samples of butter made from the untreated cream showed a calcium oxide content of about 0.032 per cent. There were however some exceptions as a few of the samples from untreated cream gave calcium oxide percentage as high as 0.07 per cent. It should be noted here that these particular samples ran exceedingly high in casein.

Professor Bouska, a member of this committee, with the assistance of J. C. Brown, has done much work along this line. They give the following figures as results of their recent work.

	CASEIN	LIME
1. Raw, very sour cream, no lime added.....	1.18	0.065
2. Country butter.....	1.31	0.004
3. Country butter.....	1.60	0.112
4. Country butter.....	1.00	0.053
5. Moderately sour, slightly neutralized with lime.....	0.69	0.068
6. Moderately sour, slightly neutralized with lime.....	1.24	0.065
7. Very sour, neutralized with lime.....	0.95	0.067
8. Very sour, excessively neutralized with lime.....	1.16	0.126

The following analytical work was reported from Cornell University last summer:

<i>CaO in butter</i>		<i>per cent</i>
Sample 1 (lime neutralized).....		0.10
Sample 2 (lime neutralized).....		0.68
Sample 3 (lime neutralized).....		0.092
Sample 4 (Na neutralized).....		0.087
Sample 5 (Na neutralized).....		0.079
Sample 6 (Na neutralized).....		0.065
Sample 7.....		0.044
Sample 8 (Na neutralized).....		0.10
Sample 9 (without any).....		0.076
Sample 10 (lime neutralized).....		0.09
Sample 11 (lime neutralized).....		0.087

BACTERIOLOGICAL DATA

From the bacteriological analysis submitted by Professor F. W. Bouska, the following data has been taken at random, covering a number of analyses of raw cream, pastuerized cream, and butter.

XI. (1) Raw cream

Molds.....	12,700
Liquefiers.....	500,000
Acid producers.....	300,000,000
Total.....	300,512,700

A composite sample of 9200 pounds of cream having an acidity of 27° testing 33 per cent butterfat. It was neutralized to 11° with 58½ pounds of milk of lime.

XI. (2) Pasteurized cream

Molds.....	0
Liquefiers.....	2,500
Acid producers.....	70,000
Total.....	72,500

Cream XI (1) after being pasteurized at 182 to 186° in a Farrington Pasteurizer, 9 per cent starter was added.

	<i>per cent</i>
Efficiency of pasteurization.....	99.976
Molds killed.....	100.0
Liquefiers killed.....	99.50
Acid producers killed.....	99.977

I. (1) Raw cream

Raw cream sample taken from vat containing 900 gallons = 7200 pounds. Neutralized to 0° acid by adding 78½ of milk of lime. Cream contained 29.05 per cent butter fat.

Molds.....	27,000
Liquefiers.....	600,000
Acid producers.....	500,000,000
Total.....	500,627,000

I. (2) Pasteurized cream

Molds.....	0
Liquefiers.....	700
Acid producers.....	195,000
Total.....	195,700

Cream I was pasteurized at 180° F. by being heated successively in a fore warmer, cooler (with hot water) two pasteurizers, and cooled on a cooler and in cream vats. 5 per cent starter was used and ripened to 34° acid. 5 per cent of sweet raw cream was also added.

	<i>per cent</i>
Efficiency of pasteurization.....	99.96
Molds killed.....	100.
Liquefiers killed.....	99.89
Acid producers killed.....	99.96

I. (3) Butter

Molds.....	0
Liquefiers.....	0
Acid producers.....	2,000,000
Total.....	2,000,000

To compare with the cream data, which are volumetric, the butter analyses were made by means of a pipette, A1 cc. pipette delivered 0.9147 gram of butter. When a planting of 0.01 cc. did not reveal any liquefiers, 1 cc. and 0.5 cc. were planted. The results showed no liquefiers whatever. The cream from I (2) yielded 2876 pounds of butter.

IX. Butter raw

Odium lactis.....	48,000
Molds.....	100
Liquefiers.....	8
Acid producers.....	310,000
Total.....	358,108

A 20 pounds tub of whole milk butter two weeks old. From Strawberry Point.

Method

Sampling was done in such a way as to obtain a composite sample.

Numbering. The Roman numbers denote the series from the same cream, The Arabic numbers show the product of the series, e.g., I (1) is raw cream; I (2) is pasteurized cream; I (3) is butter.

Bacteriological technique. 1 cc. of the material was taken and 100 cc. waterblanks containing broken glass were used. The molds, oidium, and lactic acid were counted as whey agar plates. The liquefiers were determined on sugar free gelatin. The results for butter were given per cc. so as to compare with the cream; they can be changed to grams by dividing by 0.9147 and multiplying by 10,000. A cubic centimeter of melted butter weighed 0.9147 grams.

BACTERIOLOGICAL CONCLUSIONS

In my estimation the bacteriological data here submitted would at least indicate that after cream has been as thoroughly pasteurized, as is the case in most of the larger plants, that there is but little danger of undesirable bacteria being present to any appreciable extent in the manufactured butter. Whether certain toxic products might be present or not no one seems as yet to know.

CHEMICAL CONCLUSIONS

From the meager chemical data at hand it does not seem fair to say that the use of lime has in any way injured the butter or made it detrimental to health. About the only important difference noticed in most of the chemical data is a slight tendency toward a higher calcium content in butter made from neutralized cream. (In this connection it should be understood that all my experimental work has had to do with cream neutralized with lime. Thus far my time has not permitted of any experiments in the use of bicarbonate of soda—or soda ash.)

All the experts consulted by your committee practically agree

that the use of a neutralizing substance makes it possible to handle the cream efficiently and profitably, without heavy loss in the buttermilk, and also that the quality of the butter made from carefully neutralized and pasteurized cream will score from one to 5 points higher than butter made from sour, old cream, not neutralized.

Of peculiar interest in this connection is an article on "Calcium salts as Body Builders" by Rudolph Emmerick and Oskar Loew, two noted German Scientists. The researches of these men indicate that most of our foods do not contain enough lime. The investigators cite instances in Europe and America where natives of limestone regions are better developed physically. In conclusion these scientists even suggest that a teaspoonful of a lime solution be taken with each meal. Most of us are quite familiar with the common practice of physicians recommending the use of lime water for infants. The amount of lime given the baby in one feeding of milk is considerable larger than the amount found in several pounds of butter. These facts are only mentioned in support of the contention that the use of lime in the cream could not possibly be injurious to the consumer of the butter.

Mr. Alvord, the late chief of the Dairy Division (in Year Book U. S. Dept. of Agriculture, 1900) says in speaking of the great Western states that

"They have an irregular, scanty rainfall. Long periods of drouth and hot winds are not uncommon. There are not here the woods, the great cool streams and the luxuriant grasses of the East. This country was considered fit only for grazing; farming seemed impossible; and dairying was out of the question."

The farmer here on the new and cheaper lands began slowly to compete along various lines with the farmer on the more high priced lands in the older dairy sections of the East. He gradually discovered that due to the low cost of the land, its uncropped fertility, that he could produce butter fat cheaper than his eastern brethren. The profits from wheat and other cereals however were generally so tempting that but few farmers saw their way clear to embark to any considerable extent in dairying.

Local creameries, such as he saw prospering in the thickly settled dairy sections of the eastern states were quite out of the question for a community where less than five cows to the square mile was the rule rather than the exception. Under such conditions it is quite evident that much ground has to be covered in assembling enough butterfat to operate a creamery in the thinly settled districts of Kansas, Nebraska or Colorado. Some idea of the seriousness of this problem can be noted from the statistics regarding the number of cows per square mile. From this table it will be seen that New York has something over 30.4 cows per square mile, Wisconsin, 26.83; Iowa, 24.86; Nebraska, 7.9; Kansas, 8.5; South Dakota, 4.71; and Colorado, 1.6.

No one who understands conditions on the Plains will believe that what is being done in intensive dairy sections of the east can be hoped for in the sparsely settled sections of the west for years and years to come. This country is not as a rule the home of the specific dairyman, but rather the general farmer; the man interested in large farms; in wheat raising and stock raising, and dairying, at least to start with, as a side issue. In time this type of farmer will realize more and more the importance of the proper care of the milk and cream on the farm, though as yet he feels unable to give the proper attention to this branch of his operations. As a result much of the cream produced under these conditions is very sour. Those of you familiar with the average western farm conditions will agree that in most cases this cream is bad because of the poor care, or rather lack of care, given it on the farm.

The use of lime or other alkalies was undoubtedly resorted to in order to make it possible for the creamery to so handle the poorer grades of cream as to be able to produce a grade of butter that would be decidedly better than any butter that could be made without such treatment. This generally means that the cream producer will get a market and a price not otherwise open to him. The use of lime or other alkalies are not in any sense a cure-all for all the vices and sins of the producer or the poor creamery men, and certainly its use should not be permitted to the extent of stopping or discouraging any practical or consistent

plan for real improvement made under dairy conditions. Ultimately the success of the dairy business depends in getting the farmer to produce a perfectly pure and sanitary article.

In going over the bad cream problem with the managers of some of our larger plants, I have with few exceptions, found them intensely interested in any practical scheme for raising the grade of cream received from the farm. Contrary to the views of some, I do not believe in any law preventing the shipping of certain grades of cream. Many new and fully as difficult problems would follow in the wake of such a law. The cream would likely still be produced on the farm and would not be wasted, as the farmer likely would return to farm buttermaking. In other words those farmers who ship bad cream would more than likely churn this into bad butter. Without more than the average care exercised on the ordinary farm, the chances are that the butter produced there would be decidedly worse than the butter made from the same cream in modern creameries. On account of its lack of uniformity it would undoubtedly sell as packing stock at very low prices. In my opinion, whenever we have worked out a practical and satisfactory scheme for the grading of cream, and when such a system is followed up by the creameries with a common sense plan of recognizing the difference in grades with a substantial difference in price, much will have been done towards interesting the farmer in the production of a better grade of cream. When this condition is reached there will be no need of using lime or even discussing this problem.

It would seem however that while this matter is being worked out, as it must ultimately be, that the creameries should be aided and encouraged in every possible way in producing the most wholesome article possible from the raw products at hand. As a member of the committee expressed it—"Logically dirt should be kept out of milk. It is however common practice to remove it by straining or centrifuge. Milk and cream should be produced germ free, but in practice the excessive number of bacteria are reduced by pasteurization. To reduce the acid, the product of bacteria, by neutralizing is also not ideal, but practically analogous."

The majority of this cream when its acidity is properly reduced makes at least a fair butter, which seems to satisfy the trade. If under present conditions this method of treatment was not permitted it would mean the impossibility of making, profitably, millions of pounds of butter and would shut off the dairy revenue of countless thousands of western farmers.

OPEN FORUM

WHAT IS DAIRY TEMPERAMENT?

In the judging of dairy cattle the term "dairy temperament" is used a great deal. I feel quite sure that the term does not always convey the same meaning, and many times the term expresses no definite meaning at all.

At the last National Dairy Show, a number of the dairy instructors comprising the coaches of the judging teams called together by Professor Van Norman, had much discussion on the various factors considered in judging a dairy cow. It was really a surprise what a difference of opinion existed as to just what was included under the term dairy temperament. Some included the nervous condition, others would have it mean "dairy tendency," others suggested that it meant "ability to change feeds into dairy products." Some thought that if such a meaning was attached to the term, then the whole form of the cow as it relates to milk production would be included. The final discussion simmered down to this, that by dairy temperament we mean, "that something almost indescribable in a cow, that seemed to exist in every large producing cow." Dairy temperament is similar to the general expression of an individual. We can tell there is a difference in the facial expressions of different people, but it is difficult to tell exactly what is the difference. Similarly there is a bodily expression in a dairy cow that correlates with milk production, which may be called "dairy temperament."

It has always seemed to me that to use terms in teaching, the meaning of which is not entirely clear, or to use terms in connection with judging that overlap, or to use terms that do not mean the same to different teachers, or that have no real definite meaning, is unsatisfactory.

I think that most judges of dairy cattle construe dairy temperament to mean dairy tendency or ability to change feeds into dairy products. Under this definition the whole mammary system would have to be included, also the poise, the carriage or the nervous temperament of the animal.

For a number of years I have given much thought to framing a score card that will enable both students and instructors to work understandingly and that will give the proper rating.

Among the different dairy cattle score cards I have used, the following has given the best results. I do not offer this as an ideal score card, but I would like to hear from the readers interested whether "dairy temperament" has been properly taken care of. In order to show the place assigned to dairy temperament it is necessary to give the full score card.

Date....., 191.....

SOUTH DAKOTA STATE COLLEGE
DEPARTMENT OF DAIRY HUSBANDRY
Students Score Card
Dairy Cattle

Name.....

SCORE OF POINTS	SCORE		
	Female		
	Perfect score	Student's score	Corrected score
I. ABILITY TO CONSUME AND DIGEST FEEDS (capacious and efficient digestive organs) (20 points) Chiefly indicated by:			
1. Deep, wide and medium long barrel, ribs broad and wide apart, broad, long, and not too sloping loins.....	12		
2. Large, wide mouth, not peaked.....	1		
3. Loose, mellow, medium thick skin, yellow secretion, hair soft and fine.....	7		
II. ABILITY TO CHANGE FEEDS INTO DAIRY PRODUCTS (dairy temperament) (50 points) Chiefly indicated by:			
1. Udder capacity (30 points)			
(a) Front udder extending well forward and under abdomen.....	7		
(b) Hind udder extending back and high up between flat thighs.....	7		
(c) Udder not fleshy.....	2		
(d) Udder should be wide and level underneath and four symmetrically placed teats of good size.....	4		
(e) Thighs should be flat and wide apart, giving a roomy twist.....	2		
(f) Cow should be level over hips, rump, and pinbones, and have a long, wide rump...	8		

Students Score Card—Continued.

SCORE OF POINTS	SCORE		
	Female		
	Perfect score	Students score	Corrected score
2. Blood circulation (10 points)			
(a) Large, branching, crooked and long mammary veins.....	6		
(b) Large and numerous milk wells.....	3		
(c) Long, wide spreading and well-defined escutcheon or milk mirror.....	1		
3. Poise (10 points)			
(a) Wide forehead, not too heavy and coarse in throat-latch and jaw bone.....	2		
(b) Lean, healthy, refined feminine appearance, bright eyes, well carried ears and good body carriage.....	5		
(c) Prominent, straight, open-jointed back bone, reasonably straight at tailsetting.....	3		
III. ABILITY TO MAINTAIN LIFE AND HEALTH (constitution) (15 points)			
Chiefly indicated by:			
1. Deep and wide chest and spare shoulders.....	6		
2. Large nostrils, prominent windpipe.....	2		
3. Full and large heart girth, full in foreflank, full in crops and back of shoulders.....	6		
4. Large navel.....	1		
IV. GENERAL FORM (15 points) including breed characteristics			
Chiefly indicated by:			
1. Size.....	6		
2. Color.....	2		
3. Symmetry.....	7		
Total.....	100		

C. LARSEN.

Brookings, South Dakota.

TEACHING DAIRY CATTLE JUDGING

Dairy instructors are at times censured and often, perhaps, justly on account of the methods used and the results obtained in the teaching of dairy judging. Instructors may have been open to censure and may, at times, have had meager success in developing their students into competent judges, partly at least, because we have adhered too closely to the breed score cards under the delusion that these score cards are based on known facts.

On the other hand, dairy instructors have been unjustly criticized by some followers of the show circuit who have forgotten that the chief function of any dairy cow is production, including both milk and calves.

The breed score cards have for many years been the chief reliance of the dairy instructors in their judging work. However, these score cards have never been entirely satisfactory.

First, most of the breed score cards, are in such detail that the student's mind is confused. To be comprehensive, much of the detail must be eliminated.

Second, the breed score cards have emphasized points that are not founded on known facts. Who knows for sure that the best kind of milk veins are long and crooked, or that the escutcheon should be broad, or that the tail bone should reach the hook, or that the udder should be level on the sole, or the excretions of the skin yellow? In other words, we have been teaching things that we do not know to be true.

Third, the breed score cards have not always emphasized the fact that the chief function of the dairy cow is production—the making of milk and the raising of calves. The breed score cards have taken up the points of the cow systematically, beginning at the head and working backward, without pointing out the relationship between these points and the functions of the cow which make for production. A student using such a card could hardly be criticized if he failed to associate the various detailed points with the main idea of production.

Some years ago the writer formulated a scale of points substantially the same as the one printed herewith. This scale of points in more or less modified form is now in use in several agricultural colleges in the United States. In preparing it, the aim has been to point out the relation between the appearance of the cow and her various functions which are essential to production and at the same time to avoid too much detail.

THE UNIVERSITY OF NEBRASKA

DEPARTMENT OF DAIRY HUSBANDRY

SCALE OF POINTS FOR DAIRY COWS

What is desired in the Dairy Cow is heavy and persistent producing ability combined with good breed type. The milk secreting system, dairy temperament, constitutional strength and vigor, and capacity for handling feed are the main indications of producing ability.

1. *Points Indicating Efficiency of Milk Secreting System—Forty per cent.*
 - Udder*—Large, evenly quartered, well held up, not meaty, attachments long, teats squarely placed and of convenient size for milking..... 30
 - Faults*—Udder pendulous, loosely attached to body, attachments short, substance of udder meaty or lumpy, quarters of udder uneven, teats too small, too large, or unevenly placed.
 - Milk Veins*—Capacious, branching, entering large or numerous wells..... 10
 - Faults*—Wells and veins small, veins varicose, veins large with small wells.
2. *Points Indicating Dairy Temperament—Twenty-five per cent.* Body wedge-shaped. General appearance feminine, angular and lean, yet clean cut in every part, together with good quality..... 25
 - Faults*—Undue fleshiness, coarseness, or lack of symmetry or femininity.
3. *Points Indicating Constitutional Strength and Vigor—Fifteen per cent.*
 - Nostril*—Large, open expanded..... 1
 - Faults*—Small nostril or one showing coarseness.
 - Eye*—Prominent, bright, mild intelligent..... 1
 - Faults*—Sluggish, vicious, fiery, small or deep set.
 - Chest*—Wide, deep, roomy..... 3
 - Faults*—Chest narrow or shallow.
 - General Build*—Strong and rugged for breed, yet showing good quality.
 - Pelvis* long, roomy and level..... 5
 - Faults*—Undue refinement of bones, stunted appearance, badly drooping rump, weak back, pinched pin bones, lack of width through hips.
 - Skin*—Loose and mellow, showing good circulation and secretion..... 3
 - Faults*—Skin boardy, tight, papery. Hair harsh or staring.
 - Carriage*—Energetic, prompt, alert..... 2
 - Faults*—Unduly nervous or sluggish.
4. *Points Indicating Capacity for Handling Feed—Ten per cent.*
 - Muzzle*—Large but not coarse..... 1
 - Faults*—Muzzle pointed or narrow or extremely coarse.
 - Jaw*—Wide in angle, deep, strong..... 1
 - Faults*—Jaw light, narrow in angle, or lacking in depth.
 - Barrel*—Deep, wide, long, well held up, with ribs broad, long, far apart, slanting and well sprung..... 8
 - Faults*—Flank tucked up, slab sided appearance.

5. <i>Points Indicating Breed Type—Ten per cent.</i> Points characteristic of the particular breed, such as size, color, temperament, ruggedness of build, etc.....	10
<i>Faults</i> —Markings, colors or size not typical of the breed.	
Total.....	100
Name.....	

In this scale of points the fact that the value of the dairy cow is due mainly to her producing ability is kept constantly before the student. The main considerations in the judging of the cow are then taken up in the order of their importance.

There can be no doubt but that the development of the mammary system is the best single index now known as to the producing ability of a dairy cow, and on the score card forty points are accorded the indications of its efficiency. In going over the score card with students the points emphasized are size of udder coupled with good quality. This combination usually means a productive milk secreting system.

By dairy temperament we mean the ability of the cow to convert the food she eats into milk rather than into meat. This ability can best be judged by sparseness and angularity of form coupled with evidences of thrifty condition.

The constitutional strength of a cow has commonly been judged almost entirely by the chest capacity. While the chest capacity is, perhaps, of some importance there are many other evidences of constitutional weakness, such as weak back or loin, pinched pelvis or poor nourishment of the skin.

Large capacity for handling feed in a cow is possibly not so essential to high production as it is to economy of production. It is possible that a cow of small barrel capacity if fed on a concentrated ration could supply her udder abundantly with nutrients for milk production. However, such production would not be economical. Roughages are as a rule much cheaper than the concentrates, so that the cow that can extract the largest proportion of the nutrients she requires from coarse feeds is the cow that will produce most economically.

If all dairy cows were judged by the same standard the breeds would tend to become more and more alike. There is no doubt but that the type that indicates heavy production in a Holstein cow will also indicate heavy production in a Jersey. However, the breeds are adapted to different climatic and topographical conditions on account of breed characteristics. Their milk fulfills different market conditions on

account of the different composition, so that it is essential that the characteristic type of the different breeds be kept separate. For this reason some weight on any scale of points should be attached to breed characteristics.

In using this scale of points in teaching judging a cow is brought into the pavilion and the meaning of the various items on the scale of points is explained in detail. After this the students are expected to remember the main points as well as their significance.

No cows are scored. Comparative judging is taught from the first. The students are given a placing card similar to the one printed herewith on which are listed the main divisions of the scale of points. The students rank the cows according to their merit in each division but do not score them. Filling out this card does much toward teaching the students to observe accurately. In the final placing the cow that goes first is, of course, not always the one that has been ranked first most times in the different divisions.

THE UNIVERSITY OF NEBRASKA DEPARTMENT OF DAIRY HUSBANDRY
PLACING CARD FOR DAIRY COWS
Always letter the cows A-B-C-D beginning at the right

MAIN POINTS	PER CENT	FIRST	SECOND	THIRD	FOURTH
Milk Secreting System.....	40				
Dairy Temperament.....	25				
Constitutional Strength and Vigor...	15				
Capacity for Handling Feed.....	10				
Breed Type.....	10				
Placing.....					
Class of Animals.....					
Date.....Name.....					

There are perhaps few subjects that have been taught in our agricultural colleges as long as Dairy Cattle Judging about which so little is definitely known. This will likely remain true for some time on account of the difficulty of investigating the process of milk secretion, though there is certainly need for good work to be done along this line.

E. G. WOODWARD.

Lincoln, Nebraska.

ABSTRACTS OF DAIRY LITERATURE

Studies in the Cost of Market Milk Production. A. C. ANDERSON AND F. T. RIDDELL. Bulletin 277, Michigan Agricultural Experiment Station.

The data presented in this bulletin covers a period of two years, from 1914 to 1916 and includes figures from twenty-five farms near Grand Rapids, Michigan. Most of the other figures secured on this point have been in New England or Atlantic Coast States. This data was secured by a one day visit to each farm monthly. All of the farms produced market milk, some of them being dairy farms solely, although most of them were coupled with grain, vegetables, live stock or fruit production, and each farm was conducted according to the ideas of the owner or operator.

The expenditures were as follows:

	1914	1915
Total number of farms.....	25	25
Average number of cows for year.....	459.46	428.57
Man Labor.....	\$28.63	27.19
Hauling Milk and other horse labor including R. R. Transportation when necessary.....	15.54	14.77
Feeds.....		
Roughage.....	31.02	30.33
Concentrates.....	28.61	26.68
Pastures.....	8.36	7.66
Cash sundries.....	1.96	1.77
Veterinary services and drugs.....	.86	.99
Taxes, interest and depreciation on herd.....	9.88	9.49
Taxes, interest, insurance and depreciation on buildings.....	8.72	10.33
Depreciation on barn tools and dairy utensils....	.50	.48
Actual losses from tuberculosis and other deaths.	1.95	6.25
Added earning power of owner due to knowl- edge, experience and interest in excess of that possessed and used by ordinary labor.....	6.00	6.00
Added risk due to instability of market for prod- uct as whole milk, which in single year amounts to 30 per cent, and in one year out of every five years would be 6 per cent.....	8.47	8.30
Total.....	150.57	150.29

RECEIPTS

	1914	1915
Average pounds of milk produced.....	6,928.00 lbs.	7,156.8 lbs.
Gallons of milk produced.....	834.70 gal.	862.3 gal.
Average price per gallon delivered into Grand Rapids.....	16.90¢	16.35¢
Value of milk produced.....	\$141.35	\$139.01
Credit by manure.....	17.45	17.59
Total value of products per cow.....	158.80	156.60
Net profit per cow.....	8.23	6.31
Cost of production per gallon.....	15.90¢	15.39¢
Net profit per gallon.....	1.0¢	0.7c
Cost of production and delivery per hundred weight.....	\$1.916	\$1.854
Cost of production per quart.....	3.475	3.848

The authors bring in a new point, that of "instability of market for product as whole milk" which in a single year may amount to 30 per cent and occurs as they estimate, one year in five which would be 6 per cent of the total cost of production, in this case \$8.47 for 1914 and \$8.30 for 1915. Undoubtedly this is a risk to contend with, although it would probably vary somewhat in different localities. When one considers the chance of a siege of contagious abortion, or of some disease epidemic, being traced to the herd or dairy, these figures included by the authors seem none too high.

The investment expressed percentagely is as follows:

	<i>per cent</i>
Investment in cattle.....	45
Investment in buildings.....	54
Investment in equipment.....	1

For 1915 the distribution of cost factors were as follows, expressed percentagely.

	<i>per cent</i>
Grain.....	17.8
Roughage.....	20.2
Pasture.....	5.1
Hauling milk and horse labor.....	9.8
Man labor.....	18.1
Market losses.....	5.5
Taxes, interest, insurance and depreciation of buildings.....	6.9
Same on cows.....	6.3
Tuberculosis, etc.....	4.1
Management.....	4.0
Depreciation on tools and dairy utensils.....	0.3
Veterinary services.....	0.7
Cash items.....	1.2

The authors point out that during the last two years the cost of labor has increased 25 per cent, concentrated feeds 30 to 35 per cent, roughage 10 per cent and minor supplies and milk room equipment 25 to 60 per cent.—G. C. W.

Goats' Milk for Infant Feeding. W. H. JORDAN AND G. A. SMITH. Bulletin 249 of the New York Agricultural Experiment Station.

A herd of goats given the station were kept for a number of years, during which time, milk and feed records were carefully recorded. The feed was fed collectively but the milk was weighed individually.

During 1912, three adult males, twenty-eight females and nine kids, consumed the following feeds, the cost of which is figured at prevailing prices at that time.

FEED	DAYS FED	AMOUNT USED	COST PER 100 POUNDS	TOTAL COST
		<i>pounds</i>		
Grain.....	365	14,688	1.45	212.96
Bean pods.....	199	18,180	0.35	63.63
Beets, mangel.....	46	1,550	0.20	3.11
Hay mixed.....	273	19,560	0.50	97.80
Grass.....	122	24,300	0.15	36.45
Pasture.....	132			28.00
Total.....				441.95

The average cost of feed per quart was 4 cents in 1912 and for three years during which the record was kept, 3.4 cents. The lowest cost for any one goat was 1.27 cents a quart. The average of the Jersey herd during the same period was 0.92 cent per quart.

The period of lactation continues from 250 to 300 days and a good average yield is from 700 to 900 pounds of milk. One goat however proved exceptional, producing 1028.5 pounds of milk in 1910, 1845.2 pounds of milk in 1911, and 1391.1 pounds in 1912. This is the goat that produced a quart of milk for 1.27 cents for food cost (not based upon accurate individual record).

The mixed milk of the herd tested, averaged daily from 3.4 per cent to 4.4 per cent butter fat in May and June. For the same period the total solids were from 11.34 per cent to 12.91 per cent. In August 11 goats, 33 samples from which were taken averaged 3.82 per cent butter fat, 1.0294 specific gravity, 12.12 per cent total solids, 3.21 per cent total

protein, 2.40 per cent casein and 0.55 per cent ash. The variations in fat were from 1.8 per cent to 8.4 per cent. The average composition differs only slightly from milk from average cows.

It appeared from tests made that goats milk was slightly more satisfactory in producing gain with infants than cows milk, although the analysis and a complete chemical examination of the salts, does not offer a satisfactory reason. It did appear that the curds of goats milk, when returned from the stomach, were smaller and more flocculant than cows milk and there was evidence that the goats milk was more rapidly digested.—G. C. W.

1917

Volume III

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Volume I

JOURNAL OF DAIRY SCIENCE

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EDITOR-IN-CHIEF

J. H. FRANDSEN

Professor of Dairy Husbandry, University of Nebraska
Lincoln, Nebraska

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THE INFLUENCE OF THE STAGE OF GESTATION ON THE COMPOSITION AND PROPERTIES OF MILK

LEROY S. PALMER AND C. H. ECKLES

Department of Dairy Husbandry, University of Missouri, Columbia

Among the numerous factors which exert an influence upon the composition and properties of milk, that of the stage of gestation, or pregnancy, has received practically no attention from an experimental point of view. In spite of the fact that the data on this question are exceedingly meagre, there is a wide-spread belief among medical men that the composition and properties of cows' milk are influenced by pregnancy, and an equally wide-spread opinion held by both physicians and laymen that pregnancy and lactation in the human are incompatible, and that the pregnant woman must wean her child because of the marked influence which pregnancy exerts on the composition of the milk. As evidence of this belief among physicians may be cited the fact that all regulations¹ standardizing cows' milk for human consumption exclude its use for a period of time before parturition, on the ground that cows' milk no longer has a normal composition after gestation has reached a certain stage. The authors have recently shown (1) that this assumption cannot be supported by experimental evidence.

Data which the authors have already published (2) in connection with the influence of other factors on the composition of cows' milk have been found to contain important evidence on the question of the influence which is exerted by gestation. It is the purpose of this paper to present that portion of the data which has a bearing on this question. In addition, data which have not yet been published will be presented on the influence which gestation exerts upon the composition of human milk.

¹ For example, the standards adopted for "Certified Milk" by the American Association of Medical Milk Commissions (Proc. Sixth Ann. Conference, Am. Assn. Med. Milk Comm., 1912, p. 124) exclude the milk for a period of forty-five days before parturition.

INFLUENCE OF GESTATION ON COWS' MILK

The data available for the study of this question consisted of the complete analyses of the milk and milk fat throughout the entire lactation period of ten cows which became pregnant at various stages of their lactation period, of one cow which was farrow, and the complete analyses of the milk for three of the ten cows throughout a subsequent lactation when they were kept farrow.

It is now well known that the percentage composition of cows' milk and the constitution of the milk fat, as shown by the physical and chemical constants, undergo certain definite changes as the stage of lactation progresses. These changes are usually particularly marked at the close of lactation. Since, under normal conditions, nearly all cows are bred at some stage of their lactation period, it is difficult to determine how much the fact of pregnancy or the stage of gestation contribute to these changes in the composition of the milk and milk fat.

The completeness of the data for the lactation periods of the experimental animals has made it possible to compare the composition of the milk and the milk fat at any stage of lactation with the average composition for the entire period. Inasmuch as the date of breeding of the animals occurred at different stages of lactation for each of the animals it has been possible to ascertain at what stage of lactation the composition of the milk and milk fat of each animal showed permanent changes from the average, and to note, at the same time, at what stage of gestation these changes took place. This seemed to be the fairest way to compare the relative effects of the stages of lactation and gestation upon the composition of the milk, for it seemed probable that there should be some uniformity among the different animals with regard to the stage of duration of that factor contributing the strongest influence upon the composition of the milk.

Tabulation of the results from this standpoint revealed the fact, however, that permanent changes from the average composition of the fat occurred several weeks sooner, on the average, than similar changes in the percentage composition of the milk.

The two phases of the problem have accordingly been treated separately in the tabulation of the data.

In table 1 is shown the average composition of the milk for the entire lactation period of eleven cows, one of which was farrow, in comparison with the composition of the seven-day composite which showed the first permanent change from the average, and the stages of lactation and gestation when this change occurred. Similar data for the physical and chemical constants of the milk fat are shown in table 2. The data are arranged in each case in the order of the stage of lactation when gestation began.

TABLE 1

Average composition of milk for entire lactation period of eleven cows in comparison with the composition of seven day composite showing first permanent change from the average, and the stages of lactation and gestation when this change occurred

COW	STAGE OF LACTATION WHEN BRED	STAGE OF LACTATION		STAGE OF GESTATION	TOTAL SOLIDS	PROTEIN	CASEIN	FAT	LACTOSE
		days	per cent			N. \times 6.38	N. \times 6.38		
4	47	Average for year			14.08	3.70	2.95	4.87	4.85
4		249	77	202		3.89	3.19	4.89	4.52
300	58	Average for year			12.10	3.11	2.63	3.51	4.85
300		226	75	167	12.26	3.25	3.00	3.55	5.13
402	70	Average for year			13.50	3.49	2.85	4.13	4.91
402		238	85	168	13.30	3.89	3.13	4.51	4.72
99	82	Average for year			13.43	3.27	2.65	4.64	4.95
99		264	78	182	13.85	3.45	2.87	4.74	4.80
209	122	Average for year			11.30	3.21	2.52	3.10	4.25
209		253	72	131	11.62	3.45	2.74	2.85	4.72
400	118	Average for year			13.10	3.40	2.77	3.89	5.04
400		244	80	126	13.03	3.77	2.93	3.91	4.55
206	121	Average for year			10.70	2.70	2.12	2.93	4.26
206		268	84	147	12.10	3.13	2.61	3.35	4.06
205	137	Average for year			12.00	3.00	2.46	3.23	5.05
205		312	79	175	12.19	3.32	2.87	3.50	4.94
403	148	Average for year			12.20	3.28	2.61	3.37	4.98
403		229	63	81	13.01	3.83	3.19	3.83	4.22
301	172	Average for year			12.70	3.33	2.78	3.85	4.96
301		323	86	152	13.10	3.64	3.25	4.01	5.02
118	Farrow	Average for year			14.83	3.97	3.14	5.36	4.80
118		339	82.5	Farrow	15.25	4.41	3.34	5.54	4.63
Average		268	78.3						

Before discussing these tables it may be well to point out that complete information in regard to the character of the food consumed by the cows, their milk flow, and the methods employed in the care of the animals, and the care and analyses of the samples has been given in former publications (2, a, c,) and will not be repeated here. It may be mentioned, however, that the animals were all pure-bred dairy animals, representing the Jersey, Holstein, Ayreshire and Shorthorn breeds, and were bred and raised by the University of Missouri.

An examination of the data in table 1 shows a close relation existing between a change in the percentage composition of the milk and the stage of the lactation period, particularly with respect to the relative stage of lactation. The data fail to reveal, however, that the changes in the composition of the milk bore any constant relation to the stage of gestation. Similar results are obtained on examination of the data in table 2, dealing with the composition of the milk fat. Although the relations between the changes in the constitution of the milk fat and the stage of lactation is much less constant, the same result holds true with respect to the relation to the stage of gestation. It would appear that some other factor may have been partly responsible for the changes in the composition of the milk fat.

Still more substantial evidence in regard to the influence of the stage of gestation on the composition of milk is furnished by a comparison of the composition on corresponding days of two lactation periods of the same cow, during one period of which she is pregnant and the other farrow. Such data are available for three of the cows mentioned in tables 1 and 2, namely cows 4, 206 and 400, and are presented in tables 3, 4 and 5. The stage of the lactation for which the composition of the milk is given is shown for both the lactation periods in the second column of each table. The stage of gestation at this time for the period during which pregnancy occurred is given in the first column. The tables also show the milk flow in pounds per day at each stage of the two lactation periods.

An examination of the data in tables 3, 4 and 5 shows that the same shrinkage in milk flow and the same changes in the com-

position of the milk occurred at the end of the farrow lactation as took place at the end of the pregnant lactation, but at a somewhat later stage. The slightly less effects of advanced lactation in the farrow period of cow 206 were undoubtedly due

TABLE 2

Average constitution of fat for entire lactation period of eleven cows in comparison with the composition of the seven-day composite showing first permanent change from the average, and the stages of lactation and gestation when this change occurred

cow	STAGE OF LACTATION WHEN BRED	STAGE OF LACTATION		STAGE OF GESTATION	SAPONIFICATION VALUE	REICHERT-MEISSL NUMBER	IODIN VALUE	MELTING POINT
	days	days	per cent	days			Habl.	°C.
4	47	Average for year			231.3	28.17	29.99	32.91
4		249	76.8	202	227.3	25.75	32.91	32.90
300	58	Average for year			228.4	26.34	31.14	33.75
300		184	61.5	125	224.3	24.76	34.23	34.48
402	70	Average for year			227.9	25.55	34.09	33.37
402		168	60.0	98	225.2	23.53	35.39	33.73
99	82	Average for year			228.6	28.69	28.78	32.95
99		306	90.6	224	227.9	25.30	34.62	35.70
209	122	Average for year			229.1	24.44	35.48	32.02
209		265	74.0	138	218.0	20.31	37.80	34.85
400	118	Average for year			227.6	26.89	34.08	33.56
400		258	84.0	140	222.5	24.73	35.84	35.38
206	121	Average for year			230.1	26.13	32.68	32.87
206		198	62.0	77	231.9	22.29	35.16	32.20
205	137	Average for year			228.2	25.81	34.46	33.76
205		312	79.0	175	224.5	24.41	36.44	32.95
403	148	Average for year			227.9	26.29	34.72	32.89
403		222	62.5	74	224.2	23.58	37.16	32.55
301	172	Average for year			228.2	25.52	32.06	33.20
301		247	65.8	75	227.2	24.11	33.81	32.69
118	Farrow	Average for year			228.9	23.28	32.79	32.99
118		339	82.5	Farrow	219.4	21.19	34.97	33.33
Average.....		244	72.6					

to the fact that her flow of milk was much heavier throughout the entire period, and persisted up to the very close of lactation.

It was unfortunate from the point of view of the present discussion that the data taken during the farrow period of cows 4, 206 and 400 did not include the physical and chemical constants

TABLE 3

Composition of milk of cow 4 during corresponding stage of successive lactation periods

STAGE OF GESTATION 1906-1907	STAGE OF LACTATION. 1906-1907 PREGNANT, 1907-1908 FARROW	MILK FLOW		TOTAL PROTEIN N. X 6.38		FAT		LACTOSE	
		When pregnant	When farrow	When pregnant	When farrow	When pregnant	When farrow	When pregnant	When farrow
<i>30 days ending with</i>	<i>30 days ending with</i>	<i>pounds per day</i>	<i>pounds per day</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
*	51	27.5	26.4	3.32	4.02	5.17	5.18	4.89	4.97
34	81	25.4	21.6	3.32	4.08	4.85	5.67	4.99	3.83
62	111	19.8	21.4	3.77	3.96	4.96	5.80	4.87	
97	142	20.1	20.8	3.89	3.96	4.85	5.95	5.07	4.10
125	171	18.7	20.8	3.80	4.15	5.00	5.97	5.20	4.20
153	201	16.9	17.5	3.71	4.02	4.73	6.10	4.39	4.70
188	232	16.5	15.1	3.68	4.21	4.51	5.72	4.95	4.60
216	261	13.5	15.1	3.89	4.27	4.73	5.40	4.67	4.10
244	291	16.2	16.3	4.21	4.08	5.05	5.17	4.64	4.41
272†	319	11.3	15.8	5.26	4.15	5.84	4.67	4.60	4.36
	351		14.2		4.34		5.00		4.16
	368‡§		10.1		4.47		5.20		4.36

* Gestation began on 47th day of lactation in 1906-07.

† Lactation ended on 324th day, the day of next parturition.

‡ Lactation ended on 368th day.

§ Last period sixteen days.

TABLE 4

Composition of the milk of cow 206 during corresponding stages of two lactation periods

STAGE OF GESTATION 1907-1908	STAGE OF LACTATION. 1907-1908 PREGNANT, 1910-1911 FARROW	MILK FLOW		TOTAL PROTEIN N. X 6.38		FAT		LACTOSE	
		When pregnant	When farrow	When pregnant	When farrow	When pregnant	When farrow	When pregnant	When farrow
<i>7-10 days ending with</i>	<i>7-10 days ending with</i>	<i>pounds per day</i>	<i>pounds per day</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
*	100	31.1	40.3	2.42	2.89	2.76	3.44	4.06	4.35
7	128	30.6	41.3	2.68	2.76	2.72	3.56	4.32	4.08
35	156	27.6	37.7	2.68	2.96	3.13	3.80	4.14	4.06
56	177	25.7	34.9	2.62	2.97	3.05	3.81	4.20	4.16
84	205	25.0	32.6	2.68	2.83	3.08	3.55	4.22	4.30
105	226	25.0	35.6	2.87	3.00	3.23	2.70	3.69	4.19
133	254	22.2	32.5	2.81	2.98	3.06	2.87	4.23	4.27
154	275	20.0	29.7	3.38	2.95	3.03	3.49	4.09	4.27
175	296	8.1	28.0	4.34	3.17	3.44	3.33	4.68	4.25
189†	310	8.0	26.9	4.91	3.05	3.73	2.93	4.48	4.08
	346		18.9		3.20		3.21		3.70
	386‡		18.8		3.15		3.52		4.14

* Gestation began on 121st day of lactation in 1907-1908.

† Lactation ended on 310th day.

‡ Lactation ended on 386th day.

of the milk fat. In view of the data shown in table 2 for cow 118, which was farrow throughout her entire lactation period, it seems safe to assume that the same character of change in the constitution of the milk fat of cows 4, 206 and 400 would have occurred during their farrow lactation periods as occurred during their pregnant lactation periods.

The conclusion which we draw from the data which have been presented is that gestation does not exert any direct effect upon

TABLE 5

Composition of the milk of cow 400 during corresponding stages of two lactation periods

STAGE OF GESTATION 1907-1908	STAGE OF LACTATION. 1907-1908 PREGNANT, 1910-1911 FARROW	MILK FLOW		TOTAL PROTEIN N. \times 6.38		FAT		LACTOSE	
		When pregnant	When farrow	When pregnant	When farrow	When pregnant	When farrow	When pregnant	When farrow
7-10 days ending with	7-8 DAYS ending with	pounds per day	pounds per day	per cent	per cent	per cent	per cent	per cent	per cent
*	100	17.9	20.7	2.87	3.57	3.30	3.75	5.01	4.60
7	125	20.2	19.3	3.25	3.53	3.53	3.75	4.93	4.66
35	153	19.3	16.4	3.38	3.37	3.62	4.10	5.39	4.92
63	187	17.9	16.6	3.51	3.36	3.52	3.45	5.28	4.48
84	202	17.9	16.7	3.51	3.40	3.95	3.70	5.30	4.65
105	223	18.5	15.7	3.57	3.41	3.96	3.61	5.09	4.75
133	251	15.1	14.2	3.83	3.52	4.52	3.92	4.54	4.72
154	272	7.8	9.4	3.83	3.59	4.78	4.27	3.80	4.10
175	293	5.1	8.1	3.89	3.52	4.28	4.20	3.90	4.10
189†	307	5.1	7.4	3.70	3.61	4.20	4.28	4.29	3.60
	331		6.1		3.53		4.70		2.15
	371‡		5.5		3.51		4.22		4.51

* Gestation began on 118th day of lactation, 1907-1908.

† Lactation ended 307th day.

‡ Lactation ended 371st day.

the composition and properties of cows' milk, but that gestation may affect the composition indirectly by hastening the close of lactation, which is the important factor involved in the changes in the composition of milk as lactation advances.

INFLUENCE OF GESTATION ON HUMAN MILK

Data relative to the effect of gestation on the composition of human milk are both meagre and contradictory, although the

subject has been discussed to a certain extent in the medical literature. Practically the only analyses bearing on this question which the authors have been able to find were made by Davis (3) a great many years ago. They are presented in table 6.

In addition the author observed that the milk of each of the pregnant women contained a few bodies like colostrum corpuscles, and also numerous cell-like structures and exceedingly small, but very active animalcula. Sketches of the microscopic fields are given. The animalcula were also found in the milk of the women when they were not pregnant, but they were not so numerous.

Davis concluded that, "The occurrence of pregnancy during lactation produces a very marked diminution of all the solid

TABLE 6
Influence of pregnancy on human milk (Davis)

SUBJECT	TIME OF LACTATION	TIME OF GESTATION	TOTAL SOLIDS	CASEIN	FAT	SUGAR	SALTS
	<i>months</i>	<i>months</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Mrs. B.....	11	6	5.79	2.31	1.26	2.11	0.11
Mrs. B.....	4*	0	11.34	5.79	2.29	2.85	0.41
Mrs. G.....	8	3	6.74	2.53	1.68	2.21	0.21
Mrs. G.....	3*	0	11.71	4.15	3.90	3.17	0.49

* Data taken in succeeding lactation.

or nutritive constituents of the milk, such diminution continuing to increase as the pregnancy advances." The methods of analysis used are not given in the report, but considerable doubt is thrown on the accuracy of the results on account of the high percentage of casein and low percentage of sugar reported for the samples of normal milk. It is now well-established that normal human milk contains relatively little casein, and frequently as high as 7 per cent lactose.

The author also reports clinical observations of the children whose mothers became pregnant during lactation. In each case serious digestive and nutritional disturbances followed very soon after pregnancy began and became more and more serious as long as the mothers persisted in nursing the children. In

the case of Mrs. B. this continued for six months when the child presented the appearance of extreme emaciation and anemia. The child of Mrs. G. showed a similar condition at the end of two months of its mother's pregnancy. Both children died within a few weeks after changing them to other food, the cause of death being attributed, however, in one case to "subacute meningal inflammation," and in the other case to cholera morbus.

Davis also reports clinical observations of four other women who became pregnant while nursing. In each case but one, in which pregnancy occurred during the sixth month of lactation, the children began to exhibit symptoms of imperfect digestion and nutrition within two months, and continued to do so until removed from the breast. In the exceptional case it was the mother who became anemic and was forced to wean her child after the fifth month of gestation.

Similar clinical evidence has more recently been reported by Guida (4), who states that it is rare to find in practice that a child nursed by a pregnant woman prospers and keeps in good health. As a rule they are dyspeptic, restless, irritable, pale, sleep little, and do not increase normally in weight. Guida attributes this to a scanty milk flow, and to the fact that the milk is rich in casein. The author claims to have established that there are no special substances injurious to the child, which are developed in the milk of a pregnant woman. We are not able to present his data on this point as the original paper of Guida's was not accessible.

Children nursed by pregnant mothers invariably show a rise in temperature, according to Guida, but the reason for this is not clear. He states that healthy children invariably grow ill and feverish if nursed by a pregnant woman. These symptoms are shown by twelve months old children, even when they receive other food in addition to the mother's milk. The author was not able to produce any pathological effects, however, by injecting this milk into animals.

Still another view of the effects of gestation during lactation is held by Fordyce (5), who concludes from his observations, that, "Where pregnancy and lactation overlap the foetus is likely to suffer."

The data which we have to offer on the question of the influence of gestation on the composition of human milk represent the analyses of twelve-hour composites of milk² of two negro

TABLE 7

Percentage composition of the milk of S. H. during portions of lactation and gestation periods which overlapped

TWELVE HOUR COMPOSITE FOR THE WEEK ENDING	VOLUME OF MILK	STAGE OF LAC- TATION	APPROXI- MATE STAGE OF GESTA- TION	SPECIFIC GRAVITY OF MILK	TOTAL SOLIDS	TOTAL PROTEIN N. \times 6.38	FAT	SUGAR
	cc.	days	days		per cent	per cent	per cent	per cent
<i>1908</i>								
September 10.....	60	370		1.0338	10.46	1.28	1.79	7.83
September 17.....	40	377		1.0334	10.85	1.08	2.31	7.48
September 24.....	45	384		1.0349	12.18	1.08	3.57	7.50
October 3.....	60	391		1.0300	12.50	1.02	4.02	6.58
October 10.....	50	398		1.0300	12.14	1.15	3.46	7.25
October 17.....	100	405		1.0329	12.17	1.08	3.95	6.73
October 24.....	115	412		1.0327	12.35	1.02	3.73	7.06
October 31.....	130	419		1.0331	10.93	1.02	2.54	7.20
November 7.....		426		1.0335	9.92	1.02	1.20	7.21
November 14.....	75	433	3	1.0255	12.90	1.02	4.51	
November 21.....	105	440	10	1.0310	10.31	0.89	2.01	6.70
November 28.....	170	447	17	1.0280	11.19	0.96	3.26	6.95
December 5.....	70	454	24					7.53
December 12.....	120	461	31	1.0313	10.66	1.02	1.68	6.67
December 19.....	122	468	38	1.0282	11.50	1.02	3.29	6.99
December 26.....	40	475	45	1.0256	15.29	1.15	7.42	
<i>1909</i>								
January 2.....	85	482	52	1.0293	10.81	1.15	2.48	6.73
January 9.....	115	489	59	1.0256	13.05	1.28	4.99	6.55
January 16.....	70	496	66	1.0231	13.41	1.40	5.16	6.15
January 23.....	77	503	73	1.0290	12.30	1.34	4.25	4.21
January 30.....	62	510	80	1.0300	13.25	1.79	4.97	6.00
February 6.....	30	517	87	1.0230	15.76	2.30	7.58	

women, the samples being taken in each case from the same breast at weekly intervals during portions of periods of lactation and gestation which overlapped. These data are shown in tables

² These samples were taken and the analyses made under the direction of Mr. R. H. Shaw of the Dairy Division, United States Department of Agriculture, at the time of his connection with this laboratory. The data will form a part of a more complete report of the influence of the stage of lactation on the composition of human milk which is to be published later by the Dairy Division. The authors are greatly indebted to Mr. Shaw for the use of the data.

7 and 8, together with the stages of lactation and gestation when the samples were taken. The stage of gestation is only approximate in each case since its beginning was calculated back two hundred and eighty days from the date of birth of the child.

An examination of the data in table 7 shows that subject S. H. had been nursing her child about fourteen months at the time she became pregnant. Between the second and third months of gestation the composition of the milk began to show the changes characteristic of advanced lactation, until at the end of three months the protein concentration had practically doubled, and the fat was much higher than the average. The child was weaned at this time because of a scanty milk flow, and because it was old enough to take nourishment satisfactorily from other sources. No unusual digestive or nutritional disturbances were reported except at the very beginning of pregnancy, when the child is stated to have been sick. The effects of gestation in the case of this lactation seemed to be merely a hastening of the close of lactation, with the usual changes in the composition of the milk characteristic of advanced lactation.

Gestation began after five months of lactation in the case of subject C. M., the data from which are shown in table 8. The observations were continued in her case through the fourth month of gestation without noting any marked changes in the composition of the milk. This is clearly shown by the data reported. No digestive or nutritional disturbances were reported. Information is unfortunately incomplete in regard to the subsequent history of this case. It is also impossible to state why the samples were discontinued after December 5, or whether the child was weaned at this time or subsequently. The presumption seems admissible that the milk flow became scanty after December 5, which would be in keeping with the effect of gestation in the case of subject S. H., but the composition of the milk does not show the effects of advanced lactation.

It is to be regretted that our data are not more extensive. They are characterized by a marked uniformity, however, and are in decided contrast to the only previous data on the subject, namely that published by Davis. The failure of clinical symp-

toms to appear as an accompaniment to gestation in either case also shows that digestive disturbances in the case of children nursed by pregnant mothers do not invariably appear, as was stated by Guida.

TABLE 8

Percentage composition of the milk of C. M. during portions of lactation and gestation periods which overlapped

TWELVE HOUR COMPOSITE FOR THE WEEK ENDING	VOL- UME OF MILK	STAGE OF LAC- TATION	APPROXI- MATE STAGE OF GESTA- TION	SPECIFIC GRAVITY OF MILK	TOTAL SOLIDS	TOTAL PROTEIN N. X 6.38	FAT	SUGAR
1908	cc.	days	days		per cent	per cent	per cent	per cent
April 9.....		33		1.0323	13.03	1.79	4.07	6.84
April 16.....		40		1.0320	12.67	1.66	3.15	7.08
April 23.....		47		1.0319	12.19	1.53	3.34	5.26
April 30.....	125	54		1.0324	13.23	1.40	3.92	6.83
May 7.....	105	61		1.0321	11.82	1.40	3.22	6.52
May 14.....	115	68		1.0322	11.40	1.40	2.82	6.50
May 21.....	75	75		1.0320	12.98	1.34	4.08	6.95
May 28.....	90	82		1.0310	12.93	1.60	3.95	7.05
June 11.....	100	96		1.0288	13.13	1.40	4.16	6.58
June 18.....	70	103		1.0314	12.42	1.40	3.69	
June 25.....	80	110		1.0297	12.47	1.53	3.52	7.05
July 2.....	75	117		1.0310	12.67	1.47	3.73	7.13
July 9.....	130	124		1.0306	13.00	1.34	3.97	6.90
July 16.....	115	131		1.0308	12.34	1.47	3.19	6.66
July 23.....	145	138		1.0325		1.21		6.82
July 30.....	75	145		1.0290	11.80	1.28	2.90	7.26
August 6.....	150	152	6	1.0306	12.14	1.21	3.92	7.46
August 13.....	105	157	13	1.0312		1.60		6.95
August 20.....	90	164	20	1.0303	12.81	1.21	4.09	7.76
August 27.....	100	171	27	1.0323	13.88		6.46	6.20
September 3.....	100	178	34	1.0265	12.76	1.40	4.51	6.69
September 10.....	65	185	41	1.0323	15.98	1.40	7.49	6.38
September 17.....	120	192	48	1.0293	13.65	1.66	5.18	7.24
September 24.....	110	199	55	1.0315	11.55	1.47	3.26	8.31
October 3.....	60	206	65	1.0280	14.02	1.28	5.48	7.80
October 10.....	100	213	72	1.0310	10.32	1.08	1.83	7.39
October 17.....		220	79	1.0330	10.45	1.15	2.48	
October 22.....	90	225	84	1.0335	11.24	1.21	2.93	6.66
October 31.....	80	234	93	1.0330	11.99	1.08	3.92	7.05
November 7.....		241	100	1.0329	11.76	1.40	3.52	7.23
November 14.....	65	248	107		12.22	1.15	3.82	
November 21.....	55	255	114		11.91	1.08	3.88	
November 28.....	65	262	121		12.84	1.21	4.98	6.70
December 5.....	65	269	128					8.13

Our data indicate that under normal conditions gestation exerts no influence on the composition of mother's milk, but that it may greatly hasten the close of lactation with the changes in the composition of the milk which accompanies it if lactation is sufficiently advanced when the period of gestation begins. The whole question is worthy of more extended study, particularly with regard to the disturbances in the health of the child which have been mentioned as accompanying pregnancy in the case of the mother. The variations in the composition of human milk, the factors which contribute to these variations, and the relation of these variations to the health and nutrition of the child have not received the attention they deserve. Similar information in regard to cows' milk is much more extensive at the present time. Many opinions regarding the extent of the variations to which the composition of cows' milk is subject, which were formerly held by many people, have been disproved, but are still regarded as being true for human milk. No doubt many of these opinions are equally unfounded for human milk, but the experimental data are not available to disprove them.

SUMMARY

Gestation of itself exerts no influence on the composition of either cows' milk or human milk, but it may indirectly affect it by hastening the close of lactation, which itself exerts marked changes on the composition of milk. The characteristics of the milk as the end of the lactation approaches are high concentration of protein and fat, and frequently a lower concentration of lactose. The fat of cows' milk is characterized by great depression of the saponification value and Reichert-Meissl number, and great increase in iodine value and melting point.

Disturbances in the health of the child being nursed by a pregnant mother were not observed in the two cases reported in this paper. The marked decrease in the percentage of all the solid constituents of the milk reported by another investigator as accompanying gestation in the case of human milk was not confirmed by our data.

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WHAT IS MEANT BY "QUALITY" IN MILK

H. A. HARDING, R. S. BREED, W. A. STOCKING, JR., AND E. G. HASTINGS

*The Illinois, New York and Wisconsin Agricultural Experiment Stations
coöperating*

FOREWORD

For many years the Official Dairy Instructors Association, which has recently become the American Dairy Science Association, has maintained a committee on dairy score card, which committee is responsible for the so-called "official" dairy score card. In 1912 this committee recognized the necessity for a different score card evaluating the quality of milk rather than the conditions under which milk was produced, and formed a subcommittee to study this problem. This subcommittee was later made an association committee on milk quality. Extensive investigations have been conducted particularly at the New York Agricultural Experiment Station, at Geneva, and the Illinois Agricultural Experiment Station in connection with this study, and the present publication is an analysis of the problem of milk quality as it appears to this committee after these years of study.

H. A. HARDING

*College of Agriculture and Agricultural
Experiment Station, University of Illinois*

R. S. BREED,

*New York Agricultural Experiment
Station, Geneva*

W. A. STOCKING, JR.

*New York State College of Agriculture and
Agricultural Experiment Station at
Cornell University*

E. G. HASTINGS

*College of Agriculture and Agricultural
Experiment Station, University of Wisconsin*

INTRODUCTION

The terms "good" and "bad" are often used to describe quality in milk. These terms, however, are indefinite and it is difficult to draw an arbitrary line of separation on this basis. It needs but a slight study of the milk question to recognize that the goodness or badness of milk depends upon several factors. Because of the complexity of this situation there is much confusion in the public thought regarding quality in milk. As a result, milk is still commonly sold without the use of grades to designate quality, the state of New York being one of the exceptions to this rule.

The present publication is a brief summary of previous considerations of the various sides of this question, a plea for a broader consideration of the problem of milk quality, and a suggestion regarding the line along which future progress in the improvement of city milk supplies will undoubtedly be made.

ELEMENTS OF QUALITY IN CITY MILK

Many factors combine to determine the quality of milk. Each of the factors has been recognized as important at one time or another, but apparently thus far no one has succeeded in so fully analyzing the city milk situation as to formulate a complete expression for milk quality. The following summary¹ of the elements of quality in city milk under the headings of food value, healthfulness, cleanliness, and keeping quality is an attempt at such an analysis. The order of presentation of these elements is essentially that in which they have been previously brought to public attention.

Food value

While milk is sometimes used as a beverage, the fundamental reason for the existence of the present vast traffic in milk is the

¹ This summary of elements of quality in city milk does not consider the occasional occurrence in milk of disagreeable substances, of which onions and gasoline are the most common examples, because the evident presence of such substances automatically excludes such milk from the city trade.

fact that milk is one of our most important foods. Not only does it offer energy in a readily available form, but the amount and variety of the compounds contained in milk make it a peculiarly valuable food for growing children. The present consumption of milk in this country is only about 0.6 pint per capita per day, although from the standpoint of protein, which is especially needed by the growing child, or from the standpoint of total energy as utilized by the adult, much more food value is obtainable from milk for a given sum of money than can be purchased in any comparable food. The following table recently prepared by the United States Department of Agriculture illustrates this point:

<i>Protein</i>	<i>Energy</i>
1 quart of milk is equal to:	1 quart of milk is equal to:
7 ounces of sirloin steak	11 ounces of sirloin steak
6 ounces of round steak	12 ounces of round steak
4.3 eggs	8½ eggs
8.5 ounces of fowl	10.7 ounces of fowl

In 1856 the laws of Massachusetts (2) attempted to protect milk from adulteration and since that time federal, state, and municipal authorities have enacted laws establishing standards for butter fat and the other solids in milk. It was the original conception that milk was of essentially fixed composition and that the establishment of minimum standards would stop the watering and skimming of milk. The establishment of these legal standards undoubtedly has had a pronounced effect in limiting open and gross adulteration of milk, but the secondary and unexpected effects of such enactments have been such as to raise the question whether, taken as a whole, they have been beneficial to the quality of the milk supply.

While it is true that these legal standards set definite limits to the extent to which the food value of milk could be reduced without incurring the penalty of the law, at the same time they offered indirectly stimulus for the reduction of such food value to a figure approximating these legal minimum standards.

The cost of producing milk at the farm is fairly proportional to the amount of food value in the milk. With the narrow margin

of profit which exists in milk production, there has been a strong impelling force toward the production of milk with the smallest food value that the market would accept without reduction in price. When the law prohibited the reduction of food value by the direct addition of water, the same result was frequently accomplished by the selection of animals producing milk which approached or even fell below the legal minimum limits. It is a matter of common knowledge that the milk supplies of our larger cities have been falling in food value, and today much of the milk sold in such cities is almost exactly at the legal limit of fat and below the legal limit in solids not fat.

This reduction in food value is all the more striking in view of the marked preference which the consuming public has for milk of high food value. Many progressive milk dealers recognizing this situation have offered milk high in fat content at an advanced price with commercial success.

While there is no simple, and at the same time, entirely satisfactory method of expressing the food value of milk, it may be roughly measured in a variety of ways. The housewife customarily judges the food value of milk by noting the depth of the cream line in the milk bottle. The food value of the other constituents of normal milk do not vary in absolute proportion to the fat, and therefore the fat is not an entirely accurate measure of the food value of the milk; but, at the same time, the variations in total food value are so nearly proportional to the variations in the fat of the milk that the fat content of a milk of cows may well be used as an index of the relative food value of various samples of milk. This index has the added convenience of being easily and accurately determined by means of the Babcock test.

Healthfulness

It is not enough that a bottle of milk shall have abundant cream in order to be accurately characterized as good milk. If such milk should contain even a limited number of virulent typhoid-fever organisms, it would be rejected by anyone who

was acquainted with this fact. While the milk business is conducted primarily because milk is a valuable food, the occasional appearance of an epidemic spread by the use of milk has made the public suspicious of the healthfulness of all milk. This public suspicion is a severe handicap to the milk business, and any procedure which will remove this suspicion and stimulate the increased consumption of milk will be of great economic benefit to the dairy industry as well as to the consumer.

While the possibility of milk functioning as a carrier of disease had been previously discussed, beginning about 1893 (3) the use of the tuberculin test revealed a large amount of tuberculosis in dairy cattle and the public was impressed with the danger of spreading tuberculosis through the milk (4). Later investigations, particularly those made during the past fifteen years, have fully demonstrated the danger of tuberculosis being transmitted from cows to children through the milk. Occasional epidemics (5) of septic sore throat and typhoid fever and less frequently epidemics of scarlet fever and diphtheria transmitted in the same way have given good grounds for suspicion regarding the healthfulness of the ordinary raw milk supply. The amount of danger from this source is commonly overestimated, but its existence, particularly in the case of children, is beyond question and should not be overlooked.

Health authorities, early recognizing tuberculosis of cattle as a public menace, attempted to stamp it out by the widespread application of the tuberculin test. The difficulties encountered in such an attempt made it evident that whatever may be the value of the tuberculin test as such, there is little prospect that the application of the test will become so widespread as to offer protection to the general milk supply.

It has also been recognized that tuberculosis is only one of a number of diseases which may be distributed through the milk supply. Any plan which is to make milk a safe article of food must take account, not only of diseases which may be transmitted from the cow, but also of the more formidable list of diseases which may be transmitted by the milk from the people who handle it to those who consume it. The history of certified

milk has made it evident that a careful medical supervision of both animals and men will reasonably protect the milk from danger of transmitting human diseases, but the expense of such supervision is large.

Pasteurization of milk was early advocated as a means of safeguarding the consumer from the dangers, not only of tuberculosis, but of other transmissible diseases. As with the tuberculin test, so with pasteurization, many practical difficulties were encountered in applying the process to the milk supply.

The studies of Theobald Smith (6) and of Russell and Hastings (7) which pointed out the practicability of pasteurizing milk at 140°F. for thirty minutes, mark the real beginning of modern successful milk pasteurization. This pasteurization, which both gives the desired protection against disease germs and furnishes a product satisfactory to commercial milk requirements, was the beginning of a widespread general interest in the subject. This interest has grown to the point where the regulations of the largest cities and of some of the smaller cities make such pasteurization of the general milk supply compulsory. In some instances this movement toward pasteurization has even taken the form of state enactment (8).

It is evident that if the milk supply is to be made so safe as to banish the suspicion of danger from disease germs, which is now a factor limiting the consumption of milk, the milk must either be produced under a careful medical supervision regarding the health of the cows and men or it must be properly pasteurized.

Cleanliness

In order to conform to the general opinion of a good milk, it is not sufficient that a milk shall have high food value and shall be free from danger of disease. If at the bottom of the bottle of milk there is a distinct sediment, the purchasing public will uniformly reject the milk as being of poor quality. The public is justly desirous of having a clean food supply, and there is probably no food product regarding which it is more sensitive than milk. The extreme sensitiveness of the public in this matter is due in part to the fact that milk naturally lends itself to careful

inspection. The white milk forms a natural background against which any foreign matter stands out with startling distinctness. As a result of these physical conditions the unaided eye is able to detect the presence of foreign matter in milk when it is present in such minute quantities as to practically defy detection by analytical methods. The sensitiveness of this inspection is shown by the fact that it is possible to thus find traces of foreign matter in practically any quart of milk which is critically examined, regardless of the care exercised in its production. In the certified milk from the cleanest dairies in the country which is annually brought together in competition at the National Dairy Show, such foreign matter is evident to the eye in over 80 per cent of the bottles. On the other hand, the amount of this foreign matter is so slight in all certified milk, and in practically all commercial milk, as to be upon the very margin of detection by analytical methods.

Taking advantage of the sensitiveness of the eye to differences in color, a method called the sediment test (9) has been devised for determining the cleanliness of milk. In applying this sediment test, measured quantities of milk are passed through cotton and the dirt is observed as a residue upon the white cotton. This test has been quite widely applied in commercial work. While in rare cases the presence of considerable amounts of dirt has been demonstrated, in practically all instances the amount of dirt found in the milk has been slight. When attention has been directed to the presence of any considerable quantities of dirt, the conditions of milk production have been promptly modified so as to bring the milk to a uniformly high standard of cleanliness.

Milk as it is now generally produced and handled is one of our cleanest foods.

Keeping quality

In order that a milk shall be justly entitled to be called good milk, it is not sufficient that it be high in food value, that it be free from danger of carrying disease, and that it be clean, because if it is sour when delivered to the consumer or sours promptly

thereafter, it is unsatisfactory. In the northern states, at least, the delivery of milk once a day is expected to supply the needs of the family for the succeeding twenty-four hours. Accordingly, good milk must remain sweet during that period, and preferably during a longer period, in order to justly entitle it to be called good.

It is possible to estimate the condition of the milk with regard to food value, healthfulness, and cleanliness, by comparatively simple methods. The situation with regard to keeping quality is more complex. Souring is induced by the growth in the milk of minute forms of plant life—bacteria. This plant life attacks the sugar of the milk, using it as a food, and producing acid as a by-product. When the accumulation of this acid amounts to approximately 0.3 per cent, the milk begins to taste sour; and when the accumulation of acid has reached approximately 0.7 per cent, the milk curdles. The problem of maintaining a satisfactory keeping quality is essentially a problem of restricting the development of germ life. It is possible to meet this problem either by preventing the entrance of germs, by destroying them after they enter, or by holding the milk under conditions which will prevent the activity of the germs after they enter.

While the problem of the keeping quality of milk can thus be stated in simple terms, the actual restriction of contamination and of development of germ life is a complex matter. There is still a lack of knowledge regarding the relative importance of the various avenues through which bacteria gain access to the milk, and this results in a lack of knowledge regarding the most practicable means of preventing their entrance.

In attempting to control keeping quality, various cities have made regulations establishing a maximum number of germs permissible in their milk supplies (10). These regulations did not attain the desired results, and in many cases the cities further stipulated various conditions which must accompany milk production. The establishment of bacterial standards placed upon the milk producer and the milk dealer the responsibility of translating these standards into terms of dairy processes, while the detailed recommendations formulated by the health authorities

are an attempt on their part to make this translation. In practice both these attempts have failed to accomplish the desired end. As a measure of the keeping quality there are many advantages in a direct (11) determination of the germ life, but this is a technical process not readily available to the dairy-men and accordingly has certain limitations.

The true measure of the keeping quality of milk is the time which elapses before it actually sours. This is the measure employed by the consumer, but manifestly it cannot be applied in advance at any earlier stage in the commercial life of the milk. A modification of this is possible in that samples of the milk under consideration may be held at high temperatures and the interval before curdling noted. From a comparative study of the effect of a temperature on germ growth, it would then be possible to translate this interval into the time which would elapse before the original milk would sour at the lower temperature at which it would normally be held. This procedure involves some time and technical apparatus which is not often available.

The commercial milk men have long employed the acid test, as well as their trained sense of taste and smell, in estimating the probable keeping quality of milk as delivered at their plants. By these means they have been able to anticipate somewhat the time at which milk will be no longer acceptable to the whole-milk trade, but it is only as milk approaches this limit that its condition is determinable by these means.

During the past few years there have been suggested a number of technical milk tests more or less closely related to keeping quality, such as the reductase test, the Schardinger reaction, the alcohol test, the catalase test, and the hydrogen ion concentration. In general the availability of these tests seems limited because they are mainly useful only in the later stages of the commercial life of milk.

In view of this unsatisfactory condition of knowledge regarding the measurement and control of the keeping quality of milk, the New York (12) and Illinois (13) Agricultural Experiment Stations have undertaken extended and detailed study of the

various factors affecting the entrance and growth of germ life in milk.

Complexity of the problem

The above outline of the various phases of milk quality brings out the fact that at various times the students of the milk question have been interested first in one, then in another element of milk quality, and that in connection with each such attempt they have succeeded in devising a more or less successful index of quality with regard to the particular point under observation.

This publication is designed to emphasize the fact that the quality of city milk is not a simple matter to be adequately expressed after a consideration of any one factor, but that it is a complex matter which can be expressed only after an adequate consideration and evaluation of each of these four essential factors; namely, food value, healthfulness, cleanliness, and keeping quality.

While the percentage of fat in milk is not a perfect measure of the food value, it is an easily determined index of food value. While medical supervision of the health of the cows and the men or proper pasteurization are not absolutely self-sufficient guarantees of the healthfulness of milk, they are the most practicable and easily applied indices of healthfulness. The sediment test, while open to some objections, is a simple and easily applied index of milk cleanliness. The problem of a satisfactory index for keeping quality is not so simply solved. Among the many available tests, that one must be selected which will best suit the purpose in hand.

Much of the confusion in the public mind regarding milk quality has been due to a failure to discriminate properly between germ content and healthfulness, on the one hand, and germ content and cleanliness, on the other.

The introduction of the public to the subject of germ life came through the attention which was early given to germs as producers of diseases such as tuberculosis (14) and typhoid fever. To the public, bacteria and disease became practically synonymous words. Later the attention of the public was directed to

germ life in milk (15) at about the same time that its attention was directed to the possibility of germs of tuberculosis (16) being present in milk. Therefore, it is not at all strange that in public thought germ life and unhealthfulness of milk should have seemed identical.

Early in the present century Metchnikoff (17) and other writers began to lay stress upon the health-giving qualities connected with certain germs in milk, as those of the *Bulgaricus* group. More recently extensive commercial use has been made, not only of cultured milks of various kinds, but also of vast quantities of buttermilk containing the ordinary sour-milk organisms with or without the addition of cultures of the *Bulgaricus* forms. There is a continued satisfactory use of these sour-milk drinks which contain many millions or billions of bacteria per cubic centimeter, not only of these special organisms with foreign names, but also of the organisms present in our sour milk of commerce. These experiences are gradually bringing home to the public an appreciation of the fact that there is very little connection between the amount of germ life in milk and the healthfulness of milk.

The confusion in the public thought between the presence of germ life and cleanliness of milk arises from the fact that it was originally believed that the seeding of milk with bacteria came about primarily as a result of a large quantity of bacteria being carried into the milk upon various forms of foreign matter, such as dirt and dust. Each particle of dust in the barn air was looked upon as an omnibus overloaded with attached germ life.

More recent studies have shown that dust particles, instead of being loaded in the manner described, actually carry living organisms in less than one case out of a hundred.² While it

² Compare, for example, the number of dust particles per cubic foot of air as reported on page 61 of Final Report of the Committee on Standard Methods for the Examination of Air (Am. Jour. Pub. Health, vol. 7, pp. 54-72, 1917), where the number of dust particles per cubic foot of the air of New York City streets is given as between 400,000 and 1,000,000, as determined by the filtration method, with the number of bacteria per cubic foot of air as reported by Winslow, C. E. A., and Browne, W. W. (The microbial content of indoor and outdoor air. Monthly Weather Review, vol. 42, pp. 452-453, 1914). The average numbers of bacteria which the latter authors report do not exceed 113 per cubic foot for air from the open country, from city streets, from offices, from factories, and from schools.

is true that a small number of germs are carried into the milk upon dirt, the amount of dirt actually finding its way into the milk is so small in proportion to the mass of the milk that the germ life added in this way is relatively insignificant. The confusion regarding bacteria in milk is being cleared up by studies which show that the real source of contamination of milk is either an unusual population of bacteria in the udder, or far more frequently, the presence of a surprisingly large amount of germ life upon the utensils in which the milk is handled. So persistent is this idea of the constant association of germ life and dirt that the natural inference would be that utensils carrying large numbers of germs were dirty. This inference is not in accord with the carefully observed facts, since germ life is present in vast numbers upon dairy utensils which have been rendered clean in the ordinary sense of the word, but which have not been so handled as to obliterate germ life.

Later studies of germ life in the udder (18) have made it plain that germ life is constantly present in all samples of normal milk from the time it is secreted by the glands of the udder to the time it is utilized by the consumer.

Too frequently the public thinks of milk merely as a fluid containing butter fat, while it should of course recognize the fact that milk also normally contains about 5 per cent of milk sugar, as well as varying amounts of other nitrogenous substances which become most prominent in such things as cottage cheese. Until a few years ago, few people appreciated that in the process of milk secretion, worn-out gland cells and blood corpuscles are thrown off into the milk and form a part of normal milk, since they are uniformly and regularly present in considerable numbers in all milks (19). The recentness of our appreciation of the normal presence of these cells in milk is shown by the fact that up to a few years ago in certain cities there existed regulation forbidding the presence of what are now known to be fairly normal quantities of these cells in milk.

While the public is generally aware of the fact that milk always contains considerable quantities of germ life, it has probably not yet come to appreciate the fact that germs in milk are just

as constant, and therefore just as normally a part of milk, as are milk sugar, fat globules, and body cells. The consumer has little interest in the germ content of milk except for a limited number of disease-producing forms against which he has a right to insist upon adequate protection, and except in so far as the germ life produces objectionable changes such as souring or bad flavors in the milk itself.

COMPOSITE EXPRESSIONS OF QUALITY

As has already been stated, the students of milk have recognized more or less distinctly the various elements of milk quality. However, the public mind insists upon a simple, direct statement of quality regardless of the complex relationship involved. It insists that a milk must be *good*, *medium*, or *bad*. Various plans have been devised for meeting this demand and furnishing a composite expression for milk quality.

Certified milk

Certified as applied to milk, signifies that it has the food value of normal 4 per cent milk, the healthfulness resulting from a careful medical supervision of all animals and men connected with the production and handling of the milk, the cleanliness following careful attention to the cleanliness of the animals and the utensils, and the keeping quality to be expected of fresh milk with a low germ content, kept at a very low temperature.

Score card

As a measure of the desirability of the ordinary milk supply, various dairy score cards have been suggested. These score cards are an attempt to express on a percentage basis the protection given milk on the farm from the danger of contamination with disease-producing germs both from animals and from men (healthfulness); the protection given milk from dirt (cleanliness); and the protection given milk by care of utensils, by cooling, and by prompt delivery (keeping quality). These score cards have uniformly failed to take account of the food value of the milk. Since these score cards are arranged on the basis of the

agricultural methods and equipment rather than on the basis of the milk, it is but natural that in the cards themselves there should be much confusion regarding the items which apply respectively to healthfulness, cleanliness, and keeping quality. Some have expected to find correlation between germ content and the dairy score; others feel that there should be a correlation between cleanliness of the milk from dairies and the dairy score: while others expect a correlation between the score of the dairy and the presence or absence of disease germs. Such comparisons on the basis of a single element of quality are necessarily unfair to the score card unless it is recognized that the dairy score combines factors connected with all three elements of quality.

The essential difficulties of present score cards arise from the fact that they are an attempt to evaluate the influence of dairy environment and processes upon the milk, when the relative importance of such factors has not yet been sufficiently determined.

Grade.—This presentation would be very incomplete if it did not include a suggestion as to the manner in which the four elements of milk quality herein discussed might be combined so as to form a basis for defining grades of milk. The following is offered as a suggestive outline rather than as a finished plan for milk grading:

<i>Grade</i>	<i>Element of quality</i>	<i>Degree of excellence</i>
Special milk	Food value	Fat content as stated on package
	Healthfulness	Medical supervision of health of men and animals, or proper pasteurization
	Cleanliness	Sediment, not more than a trace
	Keeping quality	Excellent
Table milk	Food value	Fat content as stated on package
	Healthfulness	Properly pasteurized
	Cleanliness	Sediment, not more than a small amount
	Keeping quality	Good
Cooking milk	Food value	Fat content as stated on package
	Healthfulness	Boiled
	Cleanliness	May not be sufficient for table grade
	Keeping quality	May not be sufficient for table grade

Under the grade of *special milk*, the plan provides for milk of any desired composition to meet any special need, such as baby feeding. The grade of *table milk* will normally include the ordinary city supply. The grade of *cooking milk* is designed for milk not sufficiently fresh or not carefully enough handled to be suitable for the table grade. In order to assist in protecting the consumer from unwittingly purchasing cooking milk instead of table milk, it is suggested that cooking milk be boiled. Such treatment will adequately protect healthfulness, and while making this grade of milk readily recognizable, will not injure it for the use for which it is designed.

RESPONSIBILITY OF THE PRODUCER FOR MILK QUALITY

If the foregoing analysis of milk quality is correct, the producer sustains somewhat different relations to each of the elements of milk quality than has been ordinarily supposed. Contrary to current belief, he is unable to control food value to any appreciable extent by his method of feeding the cow. The forces of heredity have determined what shall be the composition of the milk of a given animal, and except for slight seasonal variations or local disturbances a cow persists in giving milk of essentially a fixed composition. On the other hand, by selecting his animals he is able to produce milk of widely different food value, but at a correspondingly different cost of production. Manifestly, it must be expected that he will produce a milk having a food value which will give him the widest margin of profit.

In the matter of healthfulness, the producer has the responsibility of protecting, in so far as he is able, the milk supply from contamination by disease-producing organisms derived either from cows or people. His recognized inability to satisfactorily protect milk in this way calls for the added protection of medical supervision of the health of the cows and men, or of pasteurization; but medical inspection and pasteurization are, manifestly, not the producer's problem.

The element of cleanliness is largely in the control of the producer. Under present economic conditions, he is producing a milk with a very high degree of cleanliness, and if any additional

stress is laid upon this point he will undoubtedly produce milk which is uniformly very clean.

The element of keeping quality is the one which presents the greatest practical difficulty, because here the responsibility is much divided. Definite information regarding many details is still lacking, but the present stage of knowledge suggests that the most common contributing factor to poor keeping quality is the condition of the milk cans which are supposed to be properly treated at the milk plants. Where milking machines are used, they are very frequently a large contributing factor to the short keeping quality of the milk.

The adoption by the producer of the uniform practice of rinsing his milk utensils with scalding hot water shortly before they are used, would contribute very much to the keeping quality of the milk. In practice each utensil coming into contact with the milk adds to its germ content and decreases its keeping quality. A reduction of the number of such utensils to the minimum is very desirable.

Under ordinary conditions the udder of the cow contributes but a small number of germs and these have little effect upon the milk. Occasionally, however, cows or even herds are found where the udder content is high and the effect upon the keeping quality of the milk pronounced. Further information is necessary before the true significance of this factor can be accurately estimated.

RESPONSIBILITY OF THE DISTRIBUTOR

The responsibility of the distributor in the matter of food value concerns itself essentially with conserving the food value of the milk as furnished him by the producer. Where economic conditions permit, he is able to stimulate the production of milk with a higher food value by paying a differential price.

For the healthfulness of milk a heavy responsibility lies upon the distributor, particularly when he is charged with its pasteurization as a final safeguard to the consumer. As a possible source of disease-producing germs, human beings are more dangerous than cows, and a medical supervision of the employes

of the milk plant is desirable. This is particularly important in the case of milk pasteurized in bulk, since this process gives no protection from the later contamination, which is a more or less remote possibility during the cooling and bottling processes.

The milk as it comes from the producer usually is and always should be clean. The problem of the distributor is to preserve this cleanliness.

The keeping quality of milk is more largely within the control of the distributor than is usually supposed. He is frequently responsible for the washing and steaming of the milk cans. Where this steaming is done in a perfunctory manner, particularly where tight-fitting covers are applied to wet cans in warm weather, these cans become one of the most important factors in reducing the keeping quality of the milk. Where a proper washing of the cans is followed by a thorough steaming and the cans are carefully dried before being covered, they will have little objectionable effect upon the milk. The large germ content added to milk by utensils within the distributor's plant is frequently an important factor in impairing its keeping quality. The milk coolers and the bottling machines require special watching in this connection, not only because they frequently add large numbers of germs, but especially because they add them *after the milk has been pasteurized*.

The intelligent application of steam to all of the utensils should be a routine procedure, and the flushing out of all utensils with scalding water shortly before using them is a valuable additional precaution.

RESPONSIBILITY OF THE CONSUMER

The food value of the milk furnished the consumer will depend primarily upon what the consumer desires and is willing to pay for. A considerable proportion of the consumers are desirous of obtaining a milk carrying 4 per cent of fat or more, and where the milk has been sold regardless of food value they have striven to find the richest milk available at a given price. If each bottle of milk carried a statement of its fat content, the responsibility

would then be upon the consumer to recognize and pay for increased food value.

The consumer through his agents, the health officials, must determine how the healthfulness of the food supply shall be safeguarded. The dangers which naturally surround milk production and handling are such that if the milk supply is to be safe it must be protected either by a medical supervision of the health of the cows and the men or by proper pasteurization, or better, by a combination of both means of protection.

The cleanliness of milk, as it is now delivered to the consumer, is in general very satisfactory, but continued emphasis is needed to insure that it shall be constantly maintained at a high level.

The keeping quality of milk is constantly receiving the attention of the consumer, since there is no other shortcoming of milk which is more quickly impressed upon him. The delivery to the consumer of old, stale milk, on the verge of souring is quite as much a fraud as the delivery of milk deficient in food value, healthfulness, or cleanliness. The consumer is constantly insisting on improvement in keeping quality, and his desires will be met as rapidly as the producer and the distributor find economical means of insuring this improvement.

Since the keeping quality of milk after delivery is dependent primarily upon the temperature at which the milk is held, the responsibility rests upon the consumer to hold the milk at a reasonably low temperature after it is delivered to him. Too frequently little regard is given to this matter by the consumer, and much of the criticism directed against the keeping quality of milk is accordingly unjust.

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CONCERNING RANCIDITY OF BUTTER

E. S. GUTHRIE

Department of Dairy Industry, Cornell University

INTRODUCTION

Rancidity is a specific flavor of dairy products. It is a term that is usually used erroneously. The average person confuses it with the *strong* or the *stale* flavor, or some other "off" flavor of butter. Butter is even described in faulty terms by the federal law, when it says "non-rancid product," for undoubtedly what is meant is the *strong* flavor.

The rancid flavor of butter is not a general one. It is not the flavor that is described below. Brown (1899) defines it thus, "By the term 'Rancidity' is meant not simply as is generally supposed, a development of free acid, though this is the general concomitant of rancidity, but any chemical or physical change in the character of the fat from the normal. Rancidity, according to the present most commonly accepted understanding of the term is simply oxidation." Rahn, Brown and Smith (1909) say, "Butter is said to be rancid if it has an undesirable taste or smell, due to an aged condition, that cannot be described definitely by other terms."

The author maintains that the butter judge is the only person who is in position to determine rancidity of butter. The above mentioned men have done a great deal of research which the author wishes he might call scientific. Inasmuch as they did not build their work on a good foundation, or in other words, so long as they did not get a butter judge of repute to put them straight at the beginning, their works are absolutely worthless to the dairy world and they are of interest only as showing chemical changes. The following letters from White (1910) and Kieffer (1910) who are among the best butter judges of America,

show that rancidity of butter is not a general term but that it is very specific. White (1910) says:

If the student is given some stale tallow and told that it is rancid and then is given some stale lard and told that it is also rancid, he will be able to distinguish that the smell is not the same. If he is then given some butter which has developed a butyric acid odor he will find still a different odor, and the question would naturally be asked which of the three is and should be defined as rancid. If the odors found in the tallow and lard are rightly defined as rancid then the butyric acid odor in butter known by all butter judges, commission men, butter buyers, buttermakers and dealers in general, should be called something else as they are not the same, though that found in butter may be called rancid as a general term, meaning stale, but specifically it perhaps should be called butyric odor. The butyric odor gradually passes off since it is volatile, but there will then still remain a stale odor, and this will smell like stale tallow. On the other hand, if the butyric acid odor is the true rancid odor then the odors found in other fats and oils should not be defined as rancid.

Kieffer (1910) in answer to a letter asking for a definition of rancidity says, "I usually use that term on butter when it has an over sour strong flavor." The author once showed Mr. Kieffer some distillate of the Reichert-Meissl number, and asked if he would call it rancid. Kieffer's reply was that it resembled the rancid flavor a great deal. The distillate of the Reichert-Meissl number of butter contains the volatile fatty acids among which is butyric acid. Probably Mr. Kieffer got only enough of the butyric acid odor to make him think that it was slightly rancid. The author and many of the butter judges with whom he has conferred think that the rancid flavor of butter can best be obtained by a weak diffusion of butyric acid in the air. A small amount of butyric acid gives the characteristic flavor of rancidity. A strong solution of butyric acid does not give so characteristic a flavor of rancidity as may often be found in butter, for this acid is not found in large quantities in butter. The author knows rancidity in butter as a butyric acid flavor.

REVIEW OF PREVIOUS STUDIES ON RANCIDITY, SOME OF WHICH
WERE PROBABLY NOT STUDIES ON TRULY RANCID BUTTER

What are the causes of rancidity and is there a measure for it? Stockmeir evidently considered that there was a direct relation between the free acid and rancidity for he introduced the so-called "Degrees Rancidity" which represents the number of cubic centimeters of normal alkali required to neutralize the free acid in 100 grams of fat. Amthor (1899) says, "It has hitherto not been found possible to give numerical expression to the degree of rancidity." After a review of his own research, Amthor concludes, "It would seem that the proportion of ethylic butyrate and volatile fatty acids should be employed as the criterion of rancidity." Richmond (1899) wrote, "The action seems to be hydrolysis of the fat, splitting it up into fatty acids and glycerol; the latter perhaps is not liberated as such, but is oxidized, yielding aldehydes and acids of butter; the volatile acids are liberated and the smell of these can be detected in rancid butter." Corbetta (1891) observed that there was a reduction in the quantity of volatile fatty acids. He concludes, "The disappearance of volatile fatty acids in the rancid butter, although progressive in these experiments was in no instance very considerable." Rahn, Brown and Smith (1909) say, "We had butter without the slightest increase of acid which scored 'very rancid.'" Schmid (1893) asserts, "The acidity of a fat is not as was formerly assumed a measure of its rancidity . . . it is rancid when the glycerol has undergone partial or complete oxidation to aldehydes and ketones." Spaeth (1896) wrote, "Although the most divergent views have been put forward with regard to the cause of the development of rancidity in fats, the more recent researches (those of Duclaux, Risert and Van Klecki) have demonstrated conclusively that the process is one of oxidation by the oxygen of the air and that it is favored by access of light." After a short discussion of his research on olive oil, pigs fat, and butter, Scala (1897) says, "It is therefore concluded that rancidity depends alone on the oxidation of oleic and other acids of that series." Hagemann (1883) wrote:

The peculiar smell and taste of rancid butter is generally assumed to be due to the presence of free butyric acid either it arises from butyric fermentation at the expense of the lactose or glycerol or else is the product of chemical changes and is set free from certain glycerides in the butter. From these facts the author concludes that the rancidity of butter is not due to butyric fermentation.

Hagemann then studied the effects of lactic acid in butter. He adds,

Fresh butter when mixed with lactic acid becomes rancid very quickly, and at a temperature too low for the growth of bacteria. Pure butterfat was dissolved in ether, a few drops of lactic acid were added and the whole allowed to stand over night. The ether was then driven off at a low temperature and the residual fat proved to be strongly rancid. . . . These results indicate that the rancidity of butter is due to the formation of lactic acid by a process of fermentation from the milk sugar contained in the butter.

Reinmann (1900) studied along similar lines and found that light, warmth, or air, or all of them does, not or do not cause rancidity in sterile butter but it may become tallowy. He claims that ordinary cream under the same conditions may become rancid. He says that the length of time required for rancidity to develop, bore a relation to the casein and milk sugar content of the butter. Butter having a high casein and milk sugar content develops rancidity more quickly under the same conditions than butter with a low content of these two constituents. All of the organisms in several butter samples were isolated and studied for rancidity by being carefully inoculated into sterile cream which was churned into butter under sterile conditions. The butter was then stored. Reinmann reports that on examination many samples had produced high acidity and tallowy flavors, but that there was not a single case of rancidity.

Jensen (1902) studied the organisms of butter along the same lines as those of Reinmann. He isolated all of the organisms from butter that would grow and cultivated them separately and in mixed cultures in sterile butter. In some instances he

was able to obtain rancidity. Several species of liquefying bacilli, among them being *B. fluorescens liquefaciens*, were found. *B. prodigiosus*, *sarcina*, *oidium lactis*, *torulae*, and certain actinomycis produced high acidity in butter and in mixed cultures produced rancidity. He agrees with other investigators that acidity and rancidity are different and that they are caused by organisms.

Rogers (1902) did not find an organism that produced a marked splitting of butterfat. In 1904 he reported one *torulae* which had a weak lipolytic power. He added disinfectants to the same butter and was still able to observe a lipolytic action. This same butter when heated did not show changes and did not become rancid. He suggests that the lipolytic enzymes may have been present in the milk in the cow's udder, and that the combined action of these enzymes and the organisms already in the butter may have caused the formation of the free fatty acids and the rancid flavor. Rogers (1909) found that over-working butter churned from high acid cream produced a fishy flavor. He considered that the immediate cause was the oxidation of the acid. According to Reitz (1906) the organisms that split the butterfat to the greatest extent were *Oidium*, *Mucor*, *B. fluorescens liquefaciens*, and several species of *Saccharomyces*. Two sets of butter samples were studied. One set of thirty-three samples was placed in the incubator for about 600 days at 37°C., the other set was put in the ice box for about 600 days. All the samples became rancid.

It seems to be generally considered that rancidity is caused by the formation of volatile fatty acids and it is noticeable that the butter judges consider that there is a direct relation between the butyric acid and the rancid flavor. The author feels that if the names of reputable butter judges were mentioned in connection with many of the above accounts, the information would be worth many times more than it is. The reason is this: In the minds of the people in general any "off" flavor of butter can be classed as rancid. In reality in the twelve years of experience in teaching butter-making and in the study of butter, the writer has examined not more than six samples that

were really rancid. So long as rancidity is so rare a flavor it may be considered that in at least a few of the above accounts the flavor that was studied was not rancidity.

There are two possible sources of butyric acid in butter. First; the hydrolysis of the milk sugar into galactose and dextrose and then into lactic acid and also the further reaction, namely, the formation of butyric acid from the lactic acid. Secondly: the splitting of the butyrin into glycerol and butyric acid. Swithinbank and Newman (1903) say,

The discovery of the true state of the cause was made in 1861 by Pasteur, who showed that two successive processes are here involved. First, the conversion of sugar into lactic acid as calcium lactate and afterwards the transformation of the lactate into butyrate. He demonstrated that each of these changes is due to a special ferment; in the first place the lactate ferment, in the second place the butyric ferment. . . . Butyric acid is to be regarded in some ways as an end product of a long series of fermentative changes.

Maass (1909) sums up very pertinently the work done in his laboratory in these words, "All of these experiments seem to show that rancidity does not progress rapidly from purely chemical or physical causes." It would seem from the above discussions that rancidity is fundamentally due to a biological cause.

RESEARCH

The plan of research was outlined as follows: Is rancidity due to chemical, cow enzymic, or biological changes? On account of lack of time to study all the factors, the first two changes were the only ones investigated. So long as most of the previous investigators thought that oxidation was the main consideration in the development of rancidity, the chemical changes were studied with especial reference to the iodine number.

Description of the aspirating apparatus

The air passed through a potassium hydroxide solution (specific gravity 1.35) to remove the carbon dioxide before

the air reached the cream. The purpose of eliminating the carbon dioxide before it was drawn into the cream was to make it possible to determine whether bacteria might be growing in the cream; if bacteria did grow, it would probably be apparent by fermentation, in which case carbon dioxide would be given off. The presence of carbon dioxide was detected by the formation of barium carbonate in the barium hydroxide bottle through which the air passed after leaving the cream. Again it was desired to eliminate the carbon dioxide because of unknown reactions that might take place if it were present. In order to prevent the carbon dioxide from sucking back through the pump, a bottle of potassium hydroxide was placed between the cream and the pump. A trap was also placed between the last mentioned bottle and the cream to prevent the barium hydroxide from sucking back into the cream. With the carbon dioxide taken out of the air it was considered pure oxygen so far as this experiment was concerned. The carbon dioxide free air was delivered slowly and continuously in the bottom of the bottle so that it bubbled up through the cream, thus coming in contact with the various constituents of the cream. Rubber stoppers were used in all bottles, and rubber cement was used in all the rubber tubing and joints to insure the exclusion of the air. The bottles were kept at room temperature (70°F). Each set was allowed to stand at least three weeks. Then each sample was plated again to determine whether contamination had taken place. Of twenty samples, only eight remained sterile. Table 1 shows the results.

The effect of bringing oxygen in contact with the fat

By use of a filter pump, air was aspirated through sterile cream which tested 32 per cent fat. The cream was sterilized intermittently in a steam chest at 145°F. for thirty minutes. This of course killed both bacteria and enzymes. Cotton was placed in the ends of the glass tubes to exclude bacteria, as the air was sucked through the cream. At the end of thirty hours each set was plated to determine whether or not the samples of

cream were sterile. All sets that showed contamination were discarded.

The flavor of the cream was criticised by Prof. W. A. Stocking, Jr., Mr. H. L. Ayres and the author. All were members of the Department of Dairy Industry at Cornell University.

TABLE 1

The effect of circulating air (CO₂ free) through cream sterilized by heat

SET NO.	TIME	BOTTLE	WHAT WAS DONE	REICH- MEISSL*	ACID NO.††	IODINE NO.‡‡	REMARKS
	<i>days</i>						
I	20	0	Fresh*	24.85	0.96	42.71	
		1	Asp. O†	26.47	1.37	43.55	Flavor of rubber and KOH
		3	Asp. O†	23.09	0.96	42.92	Bitter
		4	Check‡	24.70	0.94	42.41	Slightly unpleasant
II	28	0	Fresh	25.07	0.85	45.09	
		2	Asp. O	24.51	0.92	45.23	Rubbery and cooked
III	35	0	Fresh	25.22	0.85	41.17	
		1	Asp. air§	25.42	0.85	41.60	Bitter
		4	Check	24.11	0.75	41.30	A little rubbery
IV	56	5	Check	24.13	1.04	41.37	A little rubbery
		0	Fresh	24.48	0.70	40.73	
		1	Asp. air	23.53	0.65	40.57	Trifle rubbery

* The fresh samples were analyzed after sterilization.

† "Asp. O" = Aspirated oxygen through.

‡ "Check" = Through which no oxygen was aspirated.

§ In the last two sets the air was not filtered through KOH.

** Measure of volatile fatty acids. Method described in Food Inspection and Analysis, Leach, 1911.

†† Measure of total acid. Method described in Food Inspection and Analysis, Leach, 1911.

‡‡ Measure of oxidation. Hübls method, Food Inspection and Analysis, Leach, 1911.

It will be noticed, First: There was not a rancid sample. Second: Very little change took place in any of the constants.

The relation of enzymic development in cream to rancidity

It was the purpose of the author to study only the effect of the cow enzymic development. However, because of the difficulty

of securing milk entirely free from bacteria and their enzymes, cream was used which did not contain a large number of bacteria. Had rancidity developed, the author would have taken the next step and have studied the cow enzymes alone.

Outline of experiment

Bottles were connected as in the former experiment. Instead of killing the bacteria by heat, their growth was held in check with chloroform. Harding and Van Slyke found that bacteria did not grow in a 2.5 per cent chloroform solution in normal milk, and that the enzymic development was not affected. Some spores or possibly none-spore bearers, however, were not killed, for there were some colonies on the plates from the chloroformed cream. In order to maintain a uniform content of chloroform, the aspirated air was sucked through chloroform. It was placed in the first bottle, which in the previous experiment contained potassium hydroxide. In the other bottle was placed about a tenth normal solution of potassium hydroxide instead of a stronger one.

Results of experiment

First set. In this set of ten bottles only four went through the period of twenty-nine days without contamination. In these four bottles there was no sign of rancidity. The method of determining rancidity was suggested by Prof. G. W. Cavanaugh, of Cornell University. It consisted in evaporating the tenth normal alkali solution through which the air that contained the possible rancid products was aspirated. The solution was heated until it was fairly concentrated and then a few drops of sulphuric acid were added to liberate any possible rancid products.

Second set. Every bottle of this second set was contaminated with micro-organisms.

Third set. This last set was handled in a different way. Thirty Erlenmeyer flasks each containing 100 cc. of cream (32 per cent fat) were set in an incubator at 70°F. Each flask was tightly plugged. At the end of the given time the outlet glass tube was connected quickly with the tube leading into a bottle

containing a small amount of tenth normal potassium hydroxid solution. Suction was obtained by the use of the filter pump as in the former experiment. During the aspiration which was allowed to continue for about thirty minutes, the cream flasks were suspended in warm water and also shaken a number of times; the purpose being to aid the rancid products, if any, to pass from the cream.

Of the thirty flasks in the third set, only seventeen remained uncontaminated. The following table shows the results.

TABLE 2

The effect of the development of enzymes in cream on the iodine number in which the bacterial growth was held in check by chloroform. Also the relation of enzymes to rancidity

SAMPLE NO.	AGE	NUMBER OF BACTERIA	IODINE NO.	RANCID
	<i>days</i>			
Fresh		4,150	39.54	
1	35	133	35.42	No
2	35	200	36.60	No
3	38	50	38.18	No
4	38	116	38.64	No
5	38	416	39.22	No
6	42	800	37.81	No
7	45	150	35.09	No
8	45	300	35.44	No
9	45	366	35.52	No
10	45	300	35.47	No
11	47	533	34.42	No
12	47	350	39.03	No
13	53	66	39.15	No
14	53	66	38.45	No
15	53	33	38.52	No
16	53	33	37.61	No
17	53	133	39.13	No

This table shows no rancidity. The average decrease in the iodine number was 1.3. A note should be made here of the difficulty experienced in getting the fat for the final determination. First, the chloroform had to be driven off, which required at least five hours in the drying oven. The question might be asked: Did this heating have any effect on the determination? In answer, the writer has no data to submit.

Chemical changes resulting from the effect of light, air and temperature on butter and milk fat

Brown (1899) writes, "The three factors most active in the production of rancidity in fats are (1) openness to air, (2) exposure to light, (3) degree of warmth." In the following table he gives some interesting figures on milk fat which according to his definition became rancid.

TABLE 3
Table XII of Brown (1899)

	ACID NO.	REICHERT NO.	IODINE NO.
Fresh.....	0.48	15.63	34.95
One week.....	1.28	15.80	34.55
One month.....	10.90	17.00	28.40
Two months.....	28.84	18.75	14.35
Four months.....	30.00	19.80	11.15
Eight months.....	35.38	21.13	8.55

There was a great increase in the acid number, a noticeable increase in the Reichert number and a marked decrease in the iodine number.

Corresponding results are found in table 4.

TABLE 4
Table XIII of Brown 1913*

	ACID NO.	IODINE NO.
1a Fresh.....	0.45	33.93
1b Rancid.....	1.22	29.96
2a Fresh.....	0.50	34.49
2b Rancid (one month).....	7.09	28.69
3a Fresh.....	0.55	29.56
3b Rancid (two months).....	11.73	19.76
4a Fresh.....	0.51	34.92
4b Rancid (three months).....	14.80	22.55

* Sample 1 was exposed for three months to air and light in a cold room during winter; a, represents the unoxidized bottom layer, and was unchanged; b, represents the upper oxidized part which was bleached and had an abnormal taste and smell. Samples 2b, 3b, and 4b, were allowed to become rancid in a warm place with free exposure to air and light.

Siegfeld (1909) found that melted and filtered butter when exposed to the light increased in acidity, and in the Reichert-Meissl number, and decreased in the iodine number. He says, "Oxidation is at once apparent."

Quite in contrast to the preceding statements is the report given by Crampton which agrees with the writer's work. Crampton says,

Having in mind the very radical changes brought about in oils by the process of "blowing" or oxidation, I thought it would not be difficult to establish differences in the composition of milk fat brought about by aeration to which it is subjected in the process of renovation. The results of the few experiments I have been able to make in this direction have been negative.

A sample of creamery butter was purchased early in summer and analyzed. It was freely exposed to the atmosphere of the laboratory and even inoculated with rancid butter. It was kept in this way all summer. In three months it was badly deteriorated. It was again analyzed. The remainder was renovated. The following are the results:

TABLE 5

	FRESH	THREE MONTHS	AFTER RENOVATION
Reichert-Meissl.....	27.97	27.27	27.46
Acid Value.....		4.28	4.28

It is apparent that there was practically no change.

TABLE 6

Table showing Crampton's work at the renovating factory

	REICHERT- MEISSL NO.	ACID VALUE	IODINE NO.
First experiment			
Butter fat before blowing.....	28.76	7.32	37.38
Butter fat after blowing.....	29.73	7.28	36.50
Butter, finished product.....	28.58	9.95	36.67
Butter, raw stock.....	28.56	3.98	37.09
Second experiment			
Butter fat before blowing.....	29.84	5.91	38.30
Butter fat after blowing.....	28.88	9.11	36.76
Butter, finished product.....	28.77	9.01	37.28

Here again all changes were slight.
Dyer (1916) found the following results:

TABLE 7

Chemical constants of the butter fat after being nearly freed from the non-fatty ingredients by melting, filtering, and washing and stored at 0°F.

AGE	REICHERT-MEISSL NO.	IODINE NO.
Initial.....	30.03	37.30
Two months.....	30.17	37.42
Three months.....	29.84	36.58
Four months.....	29.67	36.68

TABLE 8

Chemical constants of the fat of excessively washed butter, with low content of non-fatty ingredients, stored at 0°F.

AGE	REICHERT-MEISSL NO.	IODINE NO.
Initial.....	30.03	37.30
Two months.....	29.83	36.52
Four months.....	29.89	36.42

TABLE 9

Chemical constants of the fat of normally washed butter, with medium content of non-fatty ingredients, stored at 0°F.

AGE	REICHERT-MEISSL NO.	IODINE NO.
Initial.....	30.03	37.30
Two months.....	30.64	36.39
Three months.....	30.16	36.98
Five months.....	29.78	36.52

TABLE 10

Chemical constants of butter fat stored at 0°F after being nearly freed from the non-fatty ingredients by melting, filtering, and washing

AGE	REICHERT-MEISSL NO.	IODINE NO.
Initial.....	26.16	41.91
Two months.....	26.90	41.40
Three months.....	26.71	40.76
Five months.....	26.93	40.79
Six months.....	26.84	40.88

TABLE 11

Chemical constants of the fat of unwashed butter, with high content of non-fatty ingredients, stored at 0°F.

AGE	REICHERT-MEISSL NO.	IODINE NO.
One month.....	26.28	41.80
Two months.....	26.76	40.40
Three months.....	26.90	40.81
Five months.....	26.83	40.13
Six months.....	26.84	40.30

It should be noted that in these tables by Dyer that both the Reichert-Meissl number and the Iodine number remain practically constant during storage.

Similar to the work by Crampton and Dyer reported above, is the following report by the author. In the winter and spring of 1909, six samples of fresh milk fat were analyzed. One division of the samples was placed at 70°F., the other was held at 90°F. All of the samples faded. Most of them became snow white throughout, even though the containers were very nearly full. The samples were held in 60 cc. beakers and left open in the light of the incubators. Not a single sample developed rancidity. All became tallowy.

TABLE 12

The effect of air, temperature and diffused light on the iodine number in butter fat

SAMPLE	FRESH	70°F.				90°F.		
		Age	Surface	Middle	Bottom	Age	Surface	Bottom
		days				days		
I	30.68	38	Ave. of entire sam.		32.80	294	31.32	31.66
II	32.04	336	29.27		31.11			
II	32.04	414	26.30					
III	35.45	270	29.74	30.96	30.88	330	31.73	31.78
IV	33.30	258	32.74	32.66	33.46			
IV	33.30	404	29.09					
V	33.52	251	32.46		32.92	300	28.62	30.80
V	33.52	378	26.14					
VI	33.09	242	32.26	33.14	32.08	293	28.45	30.13

It will be noticed that there was an increase in sample I, in all three determinations of the old butter-fat. In sample IV there

was an increase in the bottom determination. There was also an increase in sample VI in the middle determination at 70°F. The most marked decrease was in sample V, in the surface determination. This decrease was 7.38. Of the twenty-five determinations the average decrease was 2.40. This includes the five determinations showing an increase. The average decrease of the surface was 3.4 and of the bottom layers 1.32.

The author analyzed one sample of old butter which had been held for twelve years in a glass fruit jar, at room temperature. It had been opened frequently. The fats seemed to have risen and the casein to have settled. The flavor was very strong but not rancid.

TABLE 13
*Butter twelve years old**

IODINE NO.	REICHERT-MEISSL NO.	ACID NO.
31.54	32.80	26.1

* The author is grateful to Prof. H. C. Troy, of Cornell University, for this sample of old butter.

The acid number was the only constant that varied from the range of fresh butter.

Another old sample of butter which likewise had changed very little, had been stored in a sealed tin can. When opened it was somewhat rancid. This rancid odor disappeared in a few hours, and then the flavor was very tallowy. The color had almost entirely disappeared.

TABLE 14
Butter 680 days old

IODINE NO.	REICHERT-MEISSL NO.	ACID NO.
33.87	34.95	5.42

Eighty-seven days later the surface of the butter fat of the above sample, which had been held in an open bottle, had an iodine number of 32.05, showing a decrease of only 1.82. Rancidity did not develop.

SUMMARY

1. The chemical changes were very slight when biological agencies were held in check. These changes did not cause rancidity.

2. The enzymic development caused very little variation in the iodine number, and it produced no rancidity.

3. The exposure of butter and butter fat to high temperatures, light and air, did not cause a marked change in the iodine number, and this exposure did not cause rancidity.

4. Rancidity of butter as defined by butter dealers and expert butter judges is rarely found. The average person thinks of the strong flavor of butter as rancid.

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THE COMPOSITION AND MARKET QUALITIES OF BUTTER WHEN CORN SILAGE IS FED WITH COTTONSEED MEAL¹

L. S. PALMER AND D. P. CROCKETT

Department of Dairy Husbandry, University of Missouri

One of the most important facts brought out in a recent bulletin (1) regarding the effects which the feeding of cottonseed products exerts upon the composition and properties of butter was the tendency for certain roughages to counteract in large measure the usual results which follow the use of cottonseed meal. Attention was directed particularly to the counteracting influence of corn silage. The greater part of the data, however, were in regard to the physical and chemical constants of the butter fat. These data showed that the depressed saponification value and Reichert-Meissl number, and augmented iodine value and melting point of butter fat which characterize the feeding of liberal amounts of cottonseed meal are returned to their normal figures when the roughage is changed to one of corn silage, and the usual changes, with the exception of a partial one in the melting point of the fat, do not occur when cottonseed meal is added to a ration in which corn silage constitutes the major part of the roughage.

The feeding of cottonseed meal with dry roughage also causes characteristic changes in the market qualities of butter. The effect of the meal first becomes evident in the changed body of the butter. It is uniformly harder and more resistant, and is usually brittle and crumbly when cold. The butter is also characterized by an oily flavor, and there is a general absence of the quick, fresh taste of normal butter, although there is more often a general lack of flavor than any taint or bad flavor. The butter is much more resistant to pressure than is normal, and the high melting point of the butter fat causes the butter to

¹ The essential facts in this paper are taken from the dissertation presented by Dura P. Crockett for the degree of Master of Arts, University of Missouri, 1917.

melt slowly in the mouth. Eckles and Palmer, in the bulletin referred to, show that some of these characteristics, particularly the oily state and hard body, attain very objectionable proportions when the ration contains relatively large amounts of whole cottonseed which is especially rich in oil.

Certain additional characteristics of butter from cottonseed meal feeding are described by these investigators. A better

TABLE 1.
Plan of experiment and average ration consumed in each period

PERIOD	DATE	GROUP I	GROUP II
		lbs.	lbs.
1	November 5 to November 23, 1916	Silage.....29	Silage.....28
		Hay*.....9	Hay.....9
		Grain†.....8	Grain.....9
2	November 23 to December 15	Silage.....29	Hay.....18
		Hay.....9	Grain.....7
		Grain.....6	Cottonseed meal....3
		Cottonseed meal....3	
3	December 15 to January 1, 1917	Silage.....29	Hay.....18
		Hay.....9	Grain.....4
		Grain.....4	Cottonseed meal....5
		Cottonseed meal....5	
4	January 1 to January 21	Silage.....29	Silage.....28
		Hay.....9	Hay.....10
		Grain.....7	Grain.....9

* The hay fed to both groups throughout the entire experiment was a mixture of equal parts alfalfa and timothy.

† The grain fed to both groups throughout the entire experiment was a mixture of corn meal two parts, distillers grains one part, wheat bran one part.

standing-up quality or resistance to heat and a marked improvement in keeping quality were found to accompany the feeding of cottonseed meal.

A somewhat limited amount of data were presented by Eckles and Palmer, however, with regard to the extent to which corn silage counteracts the peculiar market qualities of cottonseed

meal butter, just described. Inasmuch as this phase of the question is of considerable practical importance it seemed worthy of more extended study. It is the purpose of this paper to present the results of an experiment which was carried out with that end in view.

PLAN OF STUDY

Twelve pure-bred cows were selected from the University herd and divided into two groups of six cows each. At the beginning of the third period of the experiment it became necessary to drop one cow from group I on account of the rapid decrease in her milk flow. The experiment was completed with only five animals in this group. The entire study was divided into four periods. The first and last periods were basal, in which both groups received a ration of corn silage, hay and grain. In the intervening periods a portion of this grain was replaced by 3 and 5 pounds of cottonseed meal, respectively, and in addition the roughage of group II was changed to hay only. The general plan of the experiment, together with the average ration consumed by each group in each period, and the duration of each period, is shown in table 1.

All the milk produced by the two groups during the last three days of each period was separated and the cream ripened with a commercial starter. The conditions were controlled as closely as possible throughout the process of separating, holding, and churning the samples. To provide against loss or accident, the cream from each group was handled in duplicate, the first three milkings constituting the "A" churning, and the last three milkings the "B" churning. The cream was churned in a semi-commercial way, and as soon as the butter was salted and worked, samples were prepared, (1) for scoring and analysis, (2) for a study of the keeping quality, (3) for the determination of the physical and chemical constants of the fat.

One-pound prints of the butter were made for scoring. A portion of this butter was prepared for analysis for moisture, fat, curd, ash and salt according to the official method of the

American Association of Official Agricultural Chemists.² The indirect method for fat was used.

For a study of the keeping quality, six 2½ ounce metal-capped glass jars were packed with the butter from each churning. The jars containing the "B" churnings were immersed in strong brine and kept in the refrigerator, at a temperature of 8 to 12°C. One jar could thus be examined at any time without disturbing the other samples. The jars containing the "A" churnings were kept at room temperature. After the samples had been kept for a few weeks the tops were dipped in paraffin to prevent the entrance of molds, which were beginning to contaminate some of the samples. This treatment effectively prevented any further mold contamination.

For the examination of the fat constants a half pound sample for each churning was rendered, and the filtered fat subjected to analysis for saponification value, Reichert-Meissl number, iodine value (by the Hübl method) and melting point. The Leffman-Beam method was used for the Reichert-Meissl number and Wiley's method for the melting point. The results from the two churnings were averaged in each case.

RESULTS OF EXPERIMENT

Composition of butter. The analyses of the different churnings of butter for moisture, fat, curd, ash and salt are given in table 2. An examination of the figures shows no differences in the composition of the different samples of butter which can be attributed to the changes in the ration.

Score of butter. The market quality of the various samples of butter as shown by the usual method of scoring is given in table 3, together with the characteristics of the ration which have a bearing upon the results. These scores were made by Prof. M. Mortensen of the Iowa State College, who judged the samples without any knowledge of the conditions under which they were made. For this purpose samples from each churning, except those in the first basal period, were packed in paraffined cartons and shipped at once to Professor Mortensen.

² United States Department of Agriculture Bulletin 107, Bureau of Chemistry. Revised edition, 1908.

TABLE 2
Composition of butter in each period

PERIOD	GROUP	CHURNING	WATER	FAT	CURD	ASH	SALT
			<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
1	I	A	11.80				
		B	10.60				
	II	A	12.00				
		B	13.00				
2	I	A	15.68	81.50	1.12	1.73	1.72
		B	15.57	80.80	1.19	2.61	2.75
	II	A	14.90	80.50	2.08	2.77	2.75
		B	15.90	79.80	1.14	3.36	3.42
3	I	A	14.97	81.70	1.19	2.16	2.17
		B	15.52	80.95	1.06	2.54	2.05
	II	A	15.22	81.35	0.99	2.46	2.59
		B	16.62	80.15	1.07	2.21	2.26
4	I	A	15.79	81.35	0.96	2.05	2.03
		B	17.40	77.90	1.63	3.31	3.24
	II	A	15.47	79.90	1.31	3.48	3.34
		B	14.70	82.50	0.93	2.31	2.26

TABLE 3
Score of experimental samples of butter

PERIOD	GROUP	CHURNING	RATION		SCORE OF BUTTER		
			Cottonseed meal	Silage	Flavor	Body	Total
			<i>pounds per day</i>	<i>pounds per day</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
2	I	A	3	29	36.0	25	91.0
		B	3	29	37.0	25	92.0
	II	A	3	00	37.0	25	92.0
		B	3	00	37.5	25	92.5
3	I	A	5	29	36.0	25	91.0
		B	5	29	36.5	25	91.5
	II	A	5	00	37.0	25	92.0
		B	5	00	37.0	25	92.0
4	I	A	0	29	36.0	25	91.0
		B	0	29	35.5	25	90.5
	II	A	0	28	35.5	25	90.5
		B	0	28	36.0	25	91.0

On examining the data in table 3 it is seen that all the samples of butter were of good quality, the only defect from a commercial point of view being in flavor. Certain slight defects in body were noted in some cases, however, but these were not sufficiently pronounced to lead to a deduction in the score. For example, the butter from three of the churnings of period 2 was characterized as hard and brittle, but this was not noticed in the case of the "B" churning of group II. Similarly, the body of both churnings of group I in period 3 was stated to be hard, although not objectionably so, while no note was made in regard to the body of either churning from group II in this period. With regard to the oily flavor which frequently characterizes cottonseed meal butter, this was noticed only in the case of the two churnings from group I in period 3, and the "A" churning from this group in period 2, and then only to a slight extent, although the latter sample was stated to have a greasy, flat taste.

All the samples of butter were also examined by the authors in conjunction with Dr. C. H. Eckles of the Department of Dairy Husbandry, University of Missouri. The butter produced in each of the basal periods was judged to be of good quality, and very uniform in this respect among the different churnings of each of the two periods. Each of the churnings of period 2 was judged by us to have a slight taste of oil. There appeared to be no difference in this respect between the samples which could be attributed to the character of the roughage. An oily flavor and higher melting point were more noticeable in period 3. All the samples possessed these characteristics to some extent, but they seemed to be more pronounced from Group I, as was also noted by Professor Mortensen. The samples from Group II in this period seemed to be characterized more by a lack of flavor rather than by any pronounced off flavor. In no case, however, were these characteristics as pronounced as is frequently obtained in cottonseed meal feeding.

The results of the present experiment on the market qualities of the butter may be summarized as follows:

1. Cottonseed meal, when fed in quantities of 3 to 5 pounds,

imparted a slight oily flavor and harder body to the butter, but these defects were not sufficiently pronounced to detract materially from the market value of the butter.

2. The effects of the cottonseed meal feeding were fully as pronounced when fed with corn silage, as when a mixture of alfalfa and timothy hay constituted the only roughage.

Keeping quality of butter. Previous experiments carried out by this department (1) have been uniform in showing that butter made when cottonseed meal forms a part of the ration retains its original flavor appreciably longer than when no cottonseed meal is fed. Observations were accordingly made in this experiment in regard to the keeping quality of the various samples of butter. Although all the "A" churnings were kept at room temperature, and the "B" churnings at 8 to 12°C., the observations made upon the latter samples only will be reported as they imitated ordinary storage conditions more closely.

At the end of two months storage the basal samples lacked the quick flavor of fresh butter. At the end of three months a strong, old taste was sufficiently pronounced to make the butter unacceptable for table purposes. On the other hand the butter made on the cottonseed meal rations was judged to be in as good condition after two months as when put in storage, and at the end of three months was superior to that from the basal periods, being of about the same quality at this time as the basal butter at the end of two months. At the end of four months the samples from group I, which represented the feeding of cottonseed meal and silage had not deteriorated as much as the samples representing the feeding of cottonseed meal and hay.

The general result of the study, then, was to confirm the former results showing a superior keeping quality of butter made on a cottonseed meal ration over that made when the ration contains no cottonseed meal.

Chemical and physical constants of butter fat. The results of the analyses of the butter fat are shown in table 4.

The degree of heat which butter will withstand before losing its shape is of some economic importance in connection with serving the butter for table use. The highest temperature to

which butter can be heated without entirely spreading out has been designated in past studies of the kind in this department as the "standing-up temperature" of the butter. Since this point is closely related to the melting point of the butter fat the standing-up temperatures of the various samples of butter secured in this experiment have been included with the chemical and physical constants of the butter fat, and are also shown in table 4. The general method of making this determination has already been described (1) and need not be repeated. A slight improvement over the original method may, however, be mentioned.

TABLE 4
Chemical and physical constants of butter fat on different rations

PERIOD	GROUP	SAPONIFICATION VALUE	REICHERT-MEISSEL NUMBER	IODIN VALUE HÜBL.	MELTING POINT °C.	STANDING-UP TEMPERATURE °C.
1	I	234.9	31.66	28.10	32.90	34
2	I	232.9	30.95	29.01	34.18	34-35
3	I	233.4	31.03	28.88	34.10	35-36
4	I	232.2	29.63	30.22	33.03	34
1	II	236.8	33.27	29.70	32.38	33
2	II	229.2	29.63	34.69	34.35	34-35
3	II	227.4	30.01	34.42	33.98	35-36
4	II	232.5	30.73	32.11	32.45	33

The determinations reported in this paper were carried out in an electrically heated oven, in which a uniform distribution of heat was maintained by the use of a small electric fan, the blade of which was suspended through the top of the oven by means of an extended shaft.

The constants of the butter fat of group I in all periods, and of group II in periods 1 and 4 were characteristic of silage feeding as has been pointed out in a previous publication (1). Abnormally high saponification and Reichert-Meissl values and an abnormally low iodine value are the striking features of the fat constants during liberal silage feeding. The replacement of part of the grain by 3 and 5 pounds of cottonseed meal in periods 2 and 3, respectively, in the case of Group I, was without effect

upon these fat constants when the data are compared with both basal periods. This result was in entire agreement with the result secured in a similar experiment previously conducted, the data from which have already been published.¹ The melting point of the fat was increased slightly, however, by the cottonseed meal in periods 2 and 3, and this effect was also noticed in the increased standing-up temperature of the butter. This result was also in harmony with that obtained in the experiment to which reference has been made, in which the only effects of the addition of as high as 6 pounds of cottonseed meal to a ration in which silage comprised a liberal portion of the roughage was a small increase in the melting point of the fat and a similar rise in the standing-up temperature of the butter.

Very different results characterized the feeding of the cottonseed meal in periods 2 and 3 in the case of group II, in which the roughage was also changed to one of hay only. A marked depression of the saponification and Reichert-Meissl values and increase in the iodine value and melting point characterized the fat constants in these periods in comparison with the constants of the fat in the basal periods. The standing-up temperature of the butter was also increased. Such effects are characteristic of cottonseed meal feeding when dry roughage is fed. This experiment does not show, however, the extent to which the changes in the fat constants of periods 2 and 3 are due to the feeding of cottonseed meal because these periods were also characterized by a removal of silage from the ration. The results were no doubt due in part to this change in roughage.

One or two other features of the data in table 4 may be mentioned. It is noticed that the fat constants of group II were not abnormal in any of the periods, even in period 3 when 5 pounds of cottonseed meal were fed with a dry roughage of hay only. In this respect the results differ somewhat from those already published from this laboratory. They are probably due, in part at least, to the fact that the fat constants were already abnormal in the opposite direction from those which usually characterize cottonseed meal feeding when the ration was changed to include the cottonseed meal. From this point of

view the changes in the fat constants which accompanied the introduction of the meal into the ration were as great as would be expected from the amount of cottonseed meal fed.

Another feature of the data in agreement with previous experiments conducted with cottonseed meal feeding was that no greater effects were secured when 5 pounds of meal were fed to group II than when 3 pounds were fed. Previous work carried out on this question in this laboratory has shown conclusively that the effects of cottonseed products upon the constitution of butter fat are due to the oil which they contain; at the same time it was shown that less effects may frequently be expected when the oil is fed in connection with cottonseed meal, especially when moderate quantities of meal are fed, than when the oil is fed directly. It is admitted that this may not be the entire explanation of this result. No doubt the true explanation involves much more fundamental questions than are capable of explanation with the present state of knowledge of the factors governing the synthesis of milk fat.

Very great difficulty is also experienced in attempting to explain why the addition of cottonseed meal to a ration containing a liberal portion of silage fails to affect any of the fat constants except the melting point of the butter fat. Both the withdrawal of silage from the ration and the addition of cottonseed meal to a ration containing dry roughage cause changes in the fat constants in the same direction. One would expect, therefore, that the addition of cottonseed meal to a silage ration would exert whatever change is characteristic of cottonseed meal alone, although the final result might not be an abnormal butter because of the direction of the change in the fat constants which silage alone causes. Repeated experience has shown, however, that the effect of the silage feeding is apparently much stronger, at least upon the chemical constants of the milk fat, than the effect of cottonseed meal feeding. Although admittedly very inadequate, this is the only explanation the authors can suggest for the result which accompanies the addition of cottonseed meal to a ration already containing a liberal amount of corn silage.

SUMMARY

The results of the experiment reported in this paper may be summarized as follows:

1. The feeding of 3 to 5 pounds of cottonseed meal with a liberal ration of corn silage caused just as pronounced an oily flavor and as much increased hardness in the butter as when the same quantities of cottonseed meal were fed with hay alone. In neither case, however, were the market qualities of the butter impaired sufficiently to detract from its market value.

2. The use of corn silage as roughage tended to counteract the increased heat resistance of butter which accompanies the feeding of cottonseed meal.

3. The feeding of cottonseed meal materially retarded the rate of deterioration of butter kept at 8 to 12°C. This effect was secured when the cottonseed meal was fed with corn silage as well as when it was fed with hay.

4. The liberal use of corn silage in a ration counteracted all the effects which 5 pounds of cottonseed meal usually exerts upon the chemical constants of butter fat in that the addition of the cottonseed meal to a ration containing a liberal amount of corn silage was without effect upon the fat constants. A slight increase in melting point, however, accompanied the feeding of the cottonseed meal.

REFERENCE

- (1) ECKLES, C. H. AND PALMER, L. S.: Effects of feeding cottonseed products on the composition and properties of butter. Missouri Agr. Exp. Station Research Bulletin 27, pp. 44, figures 3, 1916.

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THE DAILY PER CAPITA CONSUMPTION OF MILK

H. F. JUDKINS

Department of Dairy Husbandry, Connecticut Agricultural College

While it is difficult to compile any accurate figures on the daily per capita consumption of milk it is generally conceded that the average for the United States is about 0.6 of a pint. This is a little more than a glass a day. That this is too small an amount is beyond question.

Adults in particular should remember the days of their youth and use more milk than they do. Were it not for the infant the per capita consumption would be much less than it is. According to Vermont Bulletin 195, one-sixth of the milk produced by our 22,000,000 cows is used as a food for infants and young children. It has been figured that the infant consumes 530 quarts of milk during the first year of its life.

In order to study the per capita consumption of milk first hand and find out the effect of the infant on the amount of milk used in various families data were tabulated on 27 families living in Storrs. The College retails about 90 quarts daily to residents of Storrs and hence accurate records were available. The time covered was about three months when college was in session. Families in which the exact numbers were known as well as the approximate age of children were selected. These families were divided into three groups.

It will be noted in group I that the "youngsters" were the cause of nearly doubling the consumption over group II and that it is a half pint more than in group III. It can be seen that while there is some variation in the amount used by the different families in the different groups the amount is fairly constant.

In group III it can be seen that a quart of milk is about the standard amount for a family of two. There is no better food for growing boys and girls until they reach maturity than milk. It is plainly seen that it is not realized, or at least practised by families in group II, having children three to twelve years of

12.53. 4 times for
 (to 500)

age when the consumption is much less than group I. The probable reason why the consumption is a little greater in group III than in group II is that a pint of milk was not enough to accommodate the family of two and so a quart had to be purchased and the milk used a little more freely.

The daily consumption for Storrs of 1.07 pints per capita is considerably larger than for the country. This is probably explained by the fact that the people have all had some education as to the importance of milk as a food and that they know the

Group I

Families with one or more children under three years

NUMBER OF FAMILY	NUMBER OF DAYS	NUMBER OF PINTS	AVERAGE DAILY CONSUMPTION	NUMBER IN FAMILY	AVERAGE PER CAPITA (PINTS)
1	101	418	4.13	4	1.03
2	101	472	4.67	3	1.56
3	103	793	7.69	5	1.54
4	80	468	5.85	4	1.46
5	113	633	5.60	4	1.40
6	108	782	7.15	4	1.79
7	104	574	5.48	5	1.09
8	102	454	4.45	3	1.48
9	107	624	5.83	4	1.46
10	100	461	4.61	3	1.54
Total.....	1019	5679	55.46	39	
Average.....	101.9	567.9	5.546	3.9	1.42

Group II

Families with children three to twelve years

NUMBER OF FAMILY	NUMBER OF DAYS	NUMBER OF PINTS	AVERAGE DAILY CONSUMPTION	NUMBER IN FAMILY	AVERAGE PER CAPITA (PINTS)
11	109	416	3.81	6	0.63
12	93	208	2.13	3	0.71
13	93	416	4.47	5	0.89
14	98	211	2.15	3	0.72
15	98	312	3.18	4	0.79
16	95	217	2.28	3	0.76
Total.....	586	1780	18.02	24	
Average.....	97.6	296.6	3.003	4	0.75

Group III

Families with no children

NUMBER OF FAMILY	NUMBER OF DAYS	NUMBER OF PINTS	AVERAGE DAILY CONSUMPTION	NUMBER IN FAMILY	AVERAGE PER CAPITA (PINTS)
17	79	156	1.96	2	0.98
18	89	156	1.75	2	0.78
19	94	208	2.21	2	1.10
20	24	53	2.03	2	1.10
21	64	106	1.65	2	0.83
22	82	157	1.97	2	0.96
23	75	104	1.39	2	0.69
24	93	160	1.72	2	0.86
25	74	156	2.10	3	0.70
26	92	209	2.27	2	1.14
27	71	52	0.73	2	0.37
Total.....	873	1517	19.72	23	
Average.....	76.09	135.1	1.79	2.0	0.895

Summary table

GROUPS	AVERAGE NUMBER IN FAMILY	AVERAGE DAILY CONSUMPTION (PINTS)	AVERAGE PER CAPITA CONSUMPTION (PINTS)
I	3.9	5.54	1.42
II	4.0	3.00	0.75
III	2.0	1.79	0.895
Average per 27 families.....	3.22	3.45	1.07

supply is of the best. Children under five years of age are also plentiful in Storrs.

The population of Connecticut in 1910 is given as 1,114,756. By this time it is probably at least 1,300,000. If this is the case and the average per capita consumption for this mass of people was the same as for Storrs, 1.07 pints, rather than 0.6 of a pint a day it would mean a demand for 799,000 more pounds of milk daily or 291,635,000 pounds yearly. While the recent survey on the cost of milk production showed that the average production for 3238 cows was 6009 pounds yearly it is probable that the production for the state is about 5500 pounds. This

being the case, it would take 53,024 more cows to take care of the increase in consumption of milk.

The writer was curious to get some idea as to what was the per capita consumption of milk on the farms where it was produced. A questionnaire was sent out to 25 farms, most of them retailing milk, and 17 replies were received. The data is presented below.

Table showing daily per capita consumption in pints on seventeen Connecticut dairy farms

NUMBER OF FAMILY	NUMBER IN FAMILY	NUMBER OF PINTS	DAILY PER CAPITA (PINTS)
1	6	8.0	1.33
2	6	6.0	1.00
3	2	4.0	2.00
4	4	7.0	1.75
5	6	8.0	1.33
6	4	4.0	1.00
7	3	6.0	2.00
8	5	3.0	0.60
9	5	7.0	1.40
10	3	6.0	2.00
11	6	7.0	1.16
12	8	16.0	2.00
13	10	10.4	1.04
14	7	12.0	1.71
15	6	8.0	1.33
16	13	8.0	0.61
17	6	10.0	1.66
17	100	130.4	1.30

It will be noted that there is considerable variation in different families. The average of all of them is 1.3 pints. While this is slightly larger than for those purchasing their milk it would seem that there was a chance for the farmer to use more of his own product to good advantage.

All the figures presented were obtained under winter conditions. It is probable that in the summer time the consumption is higher, both in the town and on the farm. Hot weather is the "bread and milk season" and on the farm in particular, the big pitcher of milk for drinking purposes has a prominent place.

A STUDY OF SOME FACTORS CONCERNED IN THE PREPARATION OF MILK FERMENTED WITH *B.* *BULGARICUS* AND *BACT. LACTIS ACIDI*

R. FINKELSTEIN

Department of Bacteriology, Ontario Agricultural College, Guelph, Canada

INTRODUCTION

A desire for better utilization of creamery by-products has led to the present study.¹ Natural buttermilk, as is well known, in too many cases finds its way into the drains. In some instances it is used as hog or poultry feed. In other cases, however, it is put out on the market in cities and towns to a limited extent, but has not generally gained in favor partly because of its lack of uniformity and partly because of its poor keeping quality, that is, tendency to whey off and to go off flavor.

In the disposal of skim milk, too, there is quite a noticeable waste. While much of it is fed to the growing young stock and while much of it is used in manufacturing fancy cheese, skim milk cheese, casein and milk sugar, there is at the same time a decidedly large amount of it going to waste.

A better use for buttermilk and skim milk could, perhaps, be found in the human consumption. If placed on the market in the form of properly fermented products of uniform quality and reasonably good keeping quality, they could probably fill a growing, but as yet an unstimulated, demand.

PURPOSE OF THIS STUDY

The effect of *B. bulgaricus* on ripened skim milk and on ripened whole milk has been studied at different temperatures in an effort to find out the best practical method of preparing milk drinks with these lactic acid types of organisms, as well as to determine the behaviour of different mixtures under varying treatments.

¹ The investigation had been carried out at Cornell University in 1915.

Buttermilk obtained from raw cream has a varied bacterial flora as it comes from the churn. If derived from pasteurized ripened cream, the buttermilk contains chiefly bacteria of the lactic acid type. Its body is thin and watery and it has a great tendency to whey off. To counteract this as well as to improve the flavor and the body, experiments have been performed with *B. bulgaricus* added in different proportions to buttermilk.

METHODS USED

The milk was heated in Erlenmeyer flasks in the steam bath for fifteen minutes, then rapidly cooled to 100° F. and poured into sterile 125 cc. dilution bottles till they were about three-fourths full. These were then inoculated with *B. bulgaricus* grown in sterile litmus skim milk tubes which were propagated from day to day. When ripe they were mixed, in different proportions, with freshly ripened *Bact. lactis acidii* milk, or fresh buttermilk, care being taken to run "check" bottles both on *B. bulgaricus*, *Bact. lactis acidii* and buttermilk in order to have a basis for comparison.

The mixtures and checks were prepared in three sets and each set held at a different temperature. The bottles were then examined from time to time and the effect of different temperatures on different mixtures was observed.

The results obtained in this work are indicated in the summary tables 1, 2 and 3 that follow.

In table 4 a comparison is drawn between *B. bulgaricus* cultures in skim-milk and in whole milk having different degrees of final acidity, which shows the effect of this factor on the flavor and the body of the resulting product.

RESULTS OF PRELIMINARY WORK ON PROPAGATING *B. BULGARICUS* IN MILK

1. Inoculations ranging between 0.25 and 4 per cent showed no differences in their effect on body, flavor or time required for ripening. Each one ripened pasteurized skim-milk inside of twenty-four hours at 100° F.

2. Ripening at 100° F. for two to four days does not result in the appearance of whey, but the high acid that is thus developed is obtained at the loss of body.

TABLE 1

Study of temperatures vs. keeping quality of lactic cultures and buttermilk; also study of amount of B. bulgaricus culture required to improve their body, flavor and keeping quality

TEMPERATURE	CULTURES IN PASTEURIZED SKIM-MILK
Ice-box 30-56°F.	<p>(1) B. bulgaricus culture.*—Shows excellent keeping quality. Ropiness and body but slightly lost in two to three weeks.</p> <p>(2) Bact. lactis acidi culture.†—Shows no whey inside of two to three weeks.</p> <p>(3) Bact. lactis acidi culture + 25 per cent B. bulgaricus‡.—Body keeps better than in B. bulgaricus culture only. Improved flavor as compared to Bact. lactis acidi culture only.</p>
Room 56-76°F.	<p>(1) B. bulgaricus culture.—Loses ropiness and body in five or six days.</p> <p>(2) Bact. lactis acidi culture.—No whey in four days.</p> <p>(3) Bact. lactis acidi culture + 25 per cent B. bulgaricus culture.—Body improved for four to seven days then slowly lost, but keeps better than in B.B. alone. Flavor of mixture is improved.</p>
Incubator 100°F.	<p>(1) B. bulgaricus culture.—Wheys off in two days; loses body in three days. Gains rapidly in acid and flavor.</p> <p>(2) Bact. lactis acidi culture.—Wheys off rapidly, almost immediately.</p> <p>(3) Bact. lactis acidi culture + 25 per cent B. bulgaricus culture.—Wheying off delayed for three days. B.B. makes vigorous growth till the product becomes undistinguishable from B.B. check.</p>

* Will be referred to later as B.B. culture.

† Will be referred to later as B. la. culture.

‡ Additions of B. bulgaricus culture ranging from 10 to 100 per cent have been tried out. Additions of less than 25 per cent were too small to bring about good results, while additions of more than 25 per cent made the product too acid and too thick to be palatable. Hence the addition of 25 per cent has been adhered to in these experiments.

3. Loss of body of B. bulgaricus-ripened skim-milk may be due to any one of these factors or to a combination of them—
(a) high acid development, (b) temperature, (c) age.

SOURCE OF B. BULGARICUS

Cultures of *B. bulgaricus* for use in preparation of fermented milk can be found on the market in various forms. Usually, though, the liquid cultures are preferred to the powder cultures

TABLE 2

Study of temperatures vs. keeping quality of lactic cultures and buttermilk; also study of amount of B. bulgaricus culture required to improve their body, flavor and keeping quality

TEMPERATURE	CULTURES IN PASTEURIZED WHOLE MILK
Ice-box 30-56°F.	<p>(1) <i>B. bulgaricus</i> culture.—Shows no whey or loss of body in twelve days; losses ropiness but slightly.</p> <p>(2) <i>Bact. lactis acidi</i> culture.—Shows no whey or loss of body in twelve days.</p> <p>(3) <i>Bact. lactis acidi</i> culture + 25 per cent <i>B. bulgaricus</i> culture.—Shows no whey or loss of body in 12 days. Body and flavor (mild, rich, pleasant) improved.</p>
Room 56-76°F.	<p>(1) <i>B. bulgaricus</i> culture.—No whey in 2 weeks; loses body in five to six days.</p> <p>(2) <i>Bact. lactis acidi</i> culture.—No whey and no loss of body in two weeks. Retains its body better than B.B. check or mixtures. Very rich flavor in whole milk.</p> <p>(3) <i>Bact. lactis acidi</i> culture + 25 per cent <i>B. bulgaricus</i> culture.—No whey and no loss of body in two weeks. 25 per cent addition of B.B. shows up the best flavor, as compared to 10, 50 and 100 per cent additions.</p>
Incubator 100°F.	<p>(1) <i>B. bulgaricus</i> culture.—No whey in twelve days, but body lost in two days. Does not keep its body as well as the mixtures.</p> <p>(2) <i>Bact. lactis acidi</i> culture.—Wheys off in less than a day. Body not lost.</p> <p>(3) <i>Bact. lactis acidi</i> culture + 25 per cent <i>B. bulgaricus</i> culture.—Slight wheying off at first due to <i>B. la.</i> and high temperature, but B.B. develops rapidly and prevents it. Body not lost. No whey in twelve days at least. 10, 21, 50 and 100 per cent mixtures become nearly identical after several days,—show no whey, but develop high acid and strong flavor.</p>

on account of their greater vigor. To determine the bacteriological purity of the cultures obtained, inoculate them into sterile bouillon tubes and incubate these for at least five days at

100° F. If growth takes place, it indicates contamination of the commercial culture, and if there is no evidence of growth it indicates that the culture is not contaminated. To test the activity or vigor of the same, inoculate several sterile litmus skim-milk tubes and incubate them for about twenty-four hours

TABLE 3

Study of temperatures vs. keeping quality of lactic cultures and buttermilk; also study of amount of B. bulgaricus culture required to improve their body, flavor and keeping quality

TEMPERATURE	BUTTERMILK FROM PASTEURIZED AND RIPENED CREAM
Ice-box 30-56°F.	<p>(1) Buttermilk—good flavor; becomes old and flat in five days. Thin body at the start; shows 20 per cent whey in five days.</p> <p>(2) Buttermilk + 10 per cent <i>B. bulgaricus</i> culture.—Body slightly thickened even after five days; shows 10 per cent whey.</p> <p>(3) Buttermilk + 20 per cent <i>B. bulgaricus</i> culture.—Body slightly thickened even after five days; shows 5 per cent whey. Improved flavor—nice and pleasant.</p>
Room 56-76°F.	<p>(1) Buttermilk.—Thin watery body; curd separates on standing. 60 per cent whey in one day. Flavor becomes flat in three days.</p> <p>(2) Buttermilk + 25 per cent <i>B. bulgaricus</i> culture.—Body slightly thickened; 20 per cent whey in one day; 30 per cent in three days. Improved flavor; wheying tendency reduced.</p> <p>(3) Buttermilk + 50 per cent <i>B. bulgaricus</i> culture.—Improved body; 20 per cent whey in one day; 25 per cent in three days. Moderately sharp flavor appears; wheying tendency reduced.</p>
Incubator 100°F.	<p>(1) Buttermilk.—Thin body; 75 per cent whey in one day.</p> <p>(2) Buttermilk + 25 per cent <i>B. bulgaricus</i> culture.—Body improved in three days. 30 per cent whey in one day.</p> <p>(3) Buttermilk + 50 per cent <i>B. bulgaricus</i> culture.—Body improved in one day. 30 per cent whey in one day. In three days the buttermilk flavor is lost and the <i>B. bulgaricus</i> flavor replaces it completely.</p>

at 100° F. At the end of this time, or soon after, the milk should be solidly coagulated, should show no whey and no gas, but should have a smooth, heavy body (ropy, perhaps) and a clean, sharp acid flavor.

It is possible to isolate *B. bulgaricus* from milk. Examine microscopically several different samples of milk for the possible

TABLE 4
Relations between amount of acid, flavor, body and time as factors in *B. bulgaricus* cultures

PASTEURIZED SKIM-MILK					PASTEURIZED WHOLE MILK				
Amount of acid calculated as lactic	Flavor.	Body	Held		Amount of acid calculated as lactic	Flavor.	Body	Held	
			Days	Temperature				Days	Temperature
<i>per cent</i>					<i>per cent</i>				
0.42	None	None	1	60-66°F.	0.70		Slightly thick	1	60-66°F.
0.62	None	Slightly thick	1	60-66°F.					
0.82	Slightly sour	Slightly thick	1	60-66°F.	0.95	Suggestion of a flavor	Moderately thick	1	60-66°F.
1.6	Moderately sharp	Thick	1	37°C.	1.63	Mild.	Thick	1	37°C.
1.7	Moderately sharp	Very thick	1	37°C.		Pleasant			
1.75	Moderately sharp	Fairly thick; slightly wheyed off	1	37°C.					
2.15	Very sharp	Thick	2	37°C.	2.15	Moderately sharp	Thick	2	37°C.
2.23	Very sharp	Moderately thick	Ripened at 37° C. then						
2.15	Very sharp	Thin	42	32°F.	2.15	Moderately sharp	Thick	2	37°C.
2.53	Very sharp	Very thin; wheyed off	9	32°F.	2.25	Sharp	Very heavy	1	37°C.
2.57	Very sharp	Slightly thick; slightly wheyed	7	32°F.	2.45	Very sharp	Very thin; slightly wheyed off		

NOTE: The best body and flavor in skim-milk ripened with *B. bulgaricus* are found when there is about 1.7 per cent acid. Practically the same conclusion was reached by LeRoy Lang (Illinois circular 166, May, 1913). Under similar conditions for whole milk, the best body and flavor are found when there is about 2.0 per cent acid.

presence of *B. bulgaricus* and heat, in cotton-plugged test tubes for ten minutes at 140° F., the ones giving a probable positive test. Then cool them to 100° F. and allow to sour at this temperature. This being a favorable temperature for its growth, and other organisms mostly killed off, *B. bulgaricus* that is likely to be present in milk develops in a characteristic way. Propagate the more vigorous cultures for several days by making daily transfers to sterile litmus skim-milk tubes and thus purify them. Where several tubes are available for propagation it is well to select the ones possessing the most desirable properties: vigor, flavor and body. Keep in the refrigerator as "stock" cultures for two or three weeks tubes purified and selected in this way, then propagate them and again treat some of them as "stock" cultures.

REMARKS ON PREPARATION OF MILK FERMENTED WITH
B. BULGARICUS AND *BACT. LACTIS ACIDI*

B. bulgaricus grown in milk gives a flavor moderately sharp to sharp, which is not altogether tolerable to some people. It also produces a thick, ropy body which is unsightly and in which condition it cannot be used as a beverage without an effort.

To strike a happy medium (that is, to use *B. bulgaricus* for nutritive and therapeutic purposes and to utilize to good advantage the creamery by-products) it becomes necessary to mix cultures of *B. bulgaricus* and *Bact. lactis acidi* in a proportion that would have no ropiness, that would have a slightly thick body, a distinctive pleasant taste and good keeping qualities. Such a proportion has been found in these experiments to be one part of freshly prepared *B. bulgaricus* culture and four parts buttermilk or of *Bact. lactis acidi* grown either in skim-milk or whole milk and kept at a temperature below 56° F.

As indicated elsewhere in this paper, obtain a pure culture of *B. bulgaricus* which is vigorous and which has a moderately sharp *B. bulgaricus* flavor, a thick, ropy body and no whey. Inoculate about 1-5 per cent of it into good pasteurized (150° F. for thirty minutes) milk at 100° F., mix it thoroughly and incu-

bate for twenty to twenty-four hours at this temperature. If not ready to mix at the end of that time, put away this freshly ripened milk at 56° F. or lower.

Using a good culture of *Bact. lactis acidi*, inoculate one to five per cent of it into pasteurized milk, mix it thoroughly, and incubate at 60 to 70° F. for about twenty-four hours. At that time it should be free from gas and whey, should have a fine smooth body and a mild, clean acid flavor. The acid should test about 0.7 per cent.

If the *Bact. lactis acidi* culture is good it keeps in good shape for at least two to three weeks both in skimmed and in whole milk at 32 to 76° F. At about 100° F. it wheys off at once in skim-milk and in less than a day in whole milk. The value of *B. bulgaricus* then is in prevention of wheying off of *Bact. lactis acidi* cultures at temperatures above 76° F. In order to do this it is necessary to add one part of *B. bulgaricus* culture to four parts of *Bact. lactis acidi* culture and to churn for a few minutes in order to break up lumps.

If buttermilk from pasteurized ripened cream is to be used one must use some judgment as to the amount of *B. bulgaricus* to add 10 to 20 per cent of it is necessary to improve the body and flavor of buttermilk. If whey separates out of the buttermilk too readily, it may become necessary to add as much as 30 per cent or more of a heavy-bodied, moderately flavored *B. bulgaricus* culture and to keep the mixture at a low temperature, that is, below 56° F.

Outside contamination of *B. bulgaricus* cultures must be guarded against. A common source of trouble is that of molds which are likely to get in and spoil the product. Molds grow at low and high temperatures; they grow in acid media and once they get a foothold in the cultures they are likely to be propagated in the daily transfers, unless their presence is noted and the contaminated cultures discarded. They are usually detected by their smell and taste and by the color of their spreading green colonies or brownish spots or white slimy covering on the surface of the culture, or else by microscopic examination.

A possible explanation of the formation of the firm jelly-like

body in *B. bulgaricus* milk cultures and the consequent partial loss of the same can be found in the following quotations:

Dr. Hastings (1): "Members of *Bact. bulgaricum* group do not liquefy gelatin, but casein is partly changed into soluble decomposition products."

Dr. Clement A. Penrose (2): "Probably an enzyme is formed which coagulates milk, for the curdling takes place even when the acid is neutralized with calcium carbonate or calcium chloride or zinc chloride in excess."

CONCLUSIONS

1. *B. bulgaricus* cultures partly lose with age their body and ropiness at temperatures ranging from 32 to 100° F. which is due to high acidity, or to temperature, or to age, or to reduction in bacterial numbers (3), or to a combination of any of these factors.

2. *B. lactis acidii* cultures, if not overripe at the start, have good keeping quality at temperatures ranging from 32° F. to 75° F., but whey off readily at about 100° F.

3. Twenty-five per cent of *B. bulgaricus* culture added to the *Bact. lactis acidii* culture improves the flavor of the latter, gives it more body and checks any tendency to wheying off, particularly so at 100° F., or lower. If exposed at 100° F. for too long a period, the product becomes too acid and unpalatable, due to the renewed stimulated growth of *B. bulgaricus* in the mixture.

4. Mixed cultures of *B. bulgaricus* and *Bact. lactis acidii* in pasteurized whole milk have a superior flavor and a somewhat better keeping quality than those in skim-milk. This, no doubt, is due to the presence of milk fat.

5. Twenty-five per cent of *B. bulgaricus* culture, added to the buttermilk obtained from pasteurized ripened cream, effectively checks its tendency to whey off, gives it a better body and improves the flavor, which otherwise becomes old and flat.

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THE CONTROL OF PUBLIC MILK SUPPLIES BY THE USE OF THE MICROSCOPIC METHOD¹

ROBERT S. BREED AND JAMES D. BREW

From New York Agricultural Experiment Station

At the Montreal meeting of the Society of American Bacteriologists in January, 1914, a report (1) upon the usefulness of the direct microscopic method of controlling public milk supplies was given and the conclusion was reached that this method gave promise of great usefulness. Soon afterward, plans were made for testing out the matter in a practical way. Today we are ready to give a preliminary report upon our findings.

The work which has been done consists in part of the examination of 1930 samples of market milk at the Hobart, N. Y., laboratory conducted by the Lederle Laboratories for the Sheffield Farms-Slausson, Decker Company. At this place thousands of agar plate-counts are being made yearly from samples of the milk delivered by farmers to three of the grade A plants operated by this company. Through the courtesy of Dr. H. D. Pease of the Lederle Laboratories we were permitted to use the results secured by the use of the agar plate method for a comparison with the results secured by using the microscopic method.

This work having demonstrated to our satisfaction that it was possible to grade milk by microscopic examination in at least as fair a manner as that accomplished by the use of the agar plate method, we persuaded the two local milk companies (White Springs Farm Dairy Company, and Geneva Milk Company of Geneva, N. Y.), to allow us to grade the milk which they were receiving by the microscopic method during a period of two years and to pay the farmers on the basis of our grading. The work of grading this milk was begun in a preliminary way on February 1, 1915, but the contracts did not go into effect until April 1, and the total period of our experiment will not be completed

¹ Read before the Laboratory Section of the American Public Health Association, Cincinnati, October 24, 1916.

until April 1, 1917. Thanks to the interest of the men in charge of the milk companies, their coöperation has been genuine and very helpful.

In the course of this work 9387 samples of milk have already been examined and graded by the microscopic method described in Technical Bulletin 49, (2) recently issued by the New York Agricultural Experiment Station. Counts have been made by both the microscopic method and the agar plate method in more than 600 cases. At the same time, through the courtesy and very effective coöperation of our local board of health, the effect of paying the farmers on the basis of the quality of the milk has been noted. Very little local publicity has been given to the work and the people of Geneva scarcely know that it has been done. The farmers, on the other hand, have heard of it frequently, as the results of all analyses have been mailed to them immediately after their completion, at least one visit has been made to every farm, and special studies and analyses have been made in those cases where the farmers continued to bring in poor quality milk. Very little use has been made of the dairy score card other than to carry out the requirement of the state board of health that the farms be scored at least once a year. As a result of the work which Dr. H. A. Harding did with the same group of men in 1907 to 1911 (3), nearly all of them were enabled to meet the minimum requirement of a score of 20 per cent for equipment and 35 per cent for methods though the general average score was lower than in 1911. In all cases where farmers continued to bring milk containing few bacteria, they have been left to run their own business even if they had a tumble-down stable with the manure heap piled against the barn and and many other conditions which were far from ideal.

DETAILED DISCUSSION OF THE RESULTS OBTAINED AT HOBART

The examinations of market milk which were made at Hobart were made during February, March and July of 1914. In view of the improvements in the handling of large numbers of samples for routine microscopic examination which were devised later,

the technique used at Hobart cannot be regarded as entirely satisfactory.

The plating technique used in the routine work would meet practically all of the requirements of the Standard Methods except that the plates were incubated for five days at 20° to 24°C. Only two plates were made from each sample, one being made from a dilution of 1:100 and the other from a dilution of 1:1000. The final count was ordinarily made from a single plate. The plating was done by a representative of the Lederle Laboratories.

The samples of milk were taken from individual 40-quart cans of milk as delivered by the farmers to the milk stations, located at Bloomville, South Kortright and Cobleskill. At these places, the farmers were paid a premium for delivering milk with a count less than 60,000 per cubic centimeter in the winter time and 100,000 per cubic centimeter in the summer time.

During February and March, 1504 samples of milk were examined by the microscopic method and graded "A" if it was thought that they would give a plate count under 60,000 per cubic centimeter; "B" if over 60,000. The ratings given were found to agree with those given as a result of the agar plate counts in 1339 instances (89.03 per cent). In 79 cases where the two gradings did not agree, it was because more than 60,000 colonies developed per cubic centimeter. In four of these cases the plate count was higher than 200,000 per cubic centimeter. In 86 instances where bacteria were found so abundantly by microscopic examination that it was concluded that the plate count would exceed 60,000 per cubic centimeter, later events revealed plate counts less than this, many of them being below 10,000 per cubic centimeter. In 10 of the 86 cases, bacteria were very abundant in the milk, 3 of the 10 showing a predominant long-chain streptococcus flora.

During July, 426 additional samples were examined and graded. Where it was thought that the milk would give plate counts below 100,000 it was graded "A," above 100,000 it was graded "B." The rating by both methods agreed in 362 cases (84.95 per cent). In 21 cases the microscopic rating given was "A," while the plate

count proved to be higher than 100,000. In 43 cases the microscopic rating given was "B," while the plate count proved to be less than 100,000.

Many of the discrepancies noted in these gradings occurred in the case of samples which might properly be regarded as border line samples; but there were occasional very wide discrepancies which could not be so regarded. It was impossible to decide, with the data at hand, whether the fault lay with the microscopic or with the plate method, or whether both were at fault. The percentage of agreement cannot be regarded as especially good, for it must be remembered that even if the matter were ruled entirely by the laws of chance the percentage of agreement would be 50 per cent.

DETAILED DISCUSSION OF RESULTS OBTAINED AT GENEVA

All of the work done at Geneva has been done under much more carefully controlled conditions. Microscopic counts have been made on all smears where the grade of the milk was doubtful and definite numbers have been selected as border lines between the grades, thus eliminating personal judgment so far as possible. In those cases where agar plate counts have been made, plating has been in triplicate and from three different dilutions (1:100, 1:1000, and 1:10,000). Incubation of plates has been for five days at 21°C., followed by two days at 37°C.

In the case of 355 comparative plate and microscopic counts which have been summarized, 305 samples which showed fewer than 1,000,000 individual bacteria by the microscopic count developed fewer than 200,000 colonies per cubic centimeter, 19 samples which showed more than 1,000,000 and less than 10,000,000 individual bacteria developed between 200,000 and 1,500,000 colonies per cubic centimeter on agar, while 6 samples which showed more than 10,000,000 individual bacteria developed more than 1,500,000 colonies per cubic centimeter. If the limits which have been given are accepted as the limits between "good," "medium" and "poor" milk, then there would be an agreement in rating by the two methods in the case of 330 of the

355 samples (92.95 per cent). The discrepancies noted were as follows: 11 samples of milk showed less than 1,000,000 individual bacteria and plate counts over 200,000 and less than 1,500,000 per cubic centimeter. One sample showing a microscopic count as above showed a plate count over 1,500,000; 8 samples of milk, showing more than 1,000,000 and less than 10,000,000 individual bacteria gave plate counts less than 200,000; 5 samples with microscopic counts as just given showed plate counts of more than 1,500,000 per cubic centimeter. All samples showing more than 10,000,000 individual bacteria per cubic centimeter gave plate counts in excess of 1,500,000. In other words, four out of a possible six types of discrepancies were found to occur.

In view of the fact that three grades were recognized in this work in place of the two at Hobart, it should be noted that the improvement in agreement in grading is very much greater than that indicated by the increase in percentages from 89.03 and 84.95 to 92.95 respectively. The result of the work done at Geneva has convinced us that it is impossible to secure very much better agreement in grading by the two methods than 90 to 95 per cent. The variableness in the size and compactness of the groups of bacteria found is alone sufficient to cause the ratio between plate counts and individual counts to be so variable that 100 per cent of agreement is unattainable. In addition to this, there is clear indication of the presence of a relatively small number of samples which contain either living bacteria incapable of growth on agar or bacteria which are dead.

In view of these conditions, the control work which has been done at Geneva since February 1, 1915, has been done in complete disregard of all agar plate counts, sole dependence having been placed upon the microscopic method of examination. Samples have been collected from individual 40 quart cans of milk as they were delivered at the milk stations between 6.30 and 8.30 a.m. Between 45 and 70 samples have ordinarily been collected at one time, the exact number depending upon the number of cans delivered. They have been collected at least once weekly and during two seven day periods every can of milk delivered at one of the stations was sampled. The work of collecting and ex-

aming the samples has usually been done by one of the authors (Bw.) (during his absence on vacation the work was done by Mr. W. D. Dottérrer). The report on the samples has ordinarily been ready to mail to the farmers at 3.30 p.m. Where there was anything of especial interest, the results have been telephoned. Age and temperature records have been kept as well.

No attempt has been made to make exact counts, except in the case of samples whose grades were doubtful. The reason for this was that the greatly increased amount of labor involved gave very little return in the way of valuable records. Milk having less than 1,000,000 individual bacteria per cubic centimeter has been classed as "good," this being practically equivalent to milk having a plate count of less than 200,000 per cubic centimeter. No attempt has been made to distinguish between "good" and "excellent" milk, though, as shown by the work done at Hobart, this might have been done. Milk having more than 10,000,000 bacteria per cubic centimeter was rated as "poor," this standard being apparently but little more lenient than the 1,500,000 plate count per cubic centimeter used to distinguish between B and C milk in the New York State Sanitary Code.

The greatest number of samples handled by one man in any one day was 105. On October 17, 1916, one man prepared his collecting tubes, went to a milk station one mile distant, collected 76 samples of milk, returned to the laboratory and prepared and examined these samples of milk grading them "excellent," "good," "medium" and "poor," entered the results and mailed the reports back to the farmers within seven hours time. The actual time used in making the microscopic preparations was one hour and fifteen minutes. The examination of the smears, including the preparation of the reports for the farmers took two hours. If larger numbers of samples were handled and the work organized so that the work of collecting and of examining samples were done by separate persons, the work could be done equally well in a shorter time than this. The complete record of the 76 samples referred to has been given in table 1 in order that all may have an opportunity to see their value. The original records also showed which of the "excellent,"

"good," etc., cans were p.m. and which were a.m. milk, thus giving a record of the approximate age of each can of milk. If the work had been done by the routine plating method, the records would have shown definite counts but would have failed to show the type of organism present. Moreover the labor, expense of equipment and time involved in securing them would have been much greater.

A summary has been prepared (table 2) which shows the results obtained during the first twelve months. No unexpected difficulties were met with in carrying out this system of grading and very few complaints of unfair treatment from the farmers have been received. These have been very easy to handle, as all microscopic preparations have been kept on file. Whenever a farmer came to the laboratory to object, he was shown the milk from his own herd under the microscope with the bacteria in it. An especial effort has been made to get the farmers to come to the laboratory and they have been found to be much more interested in looking through a microscope at the bacteria themselves than in looking at colonies on agar plates. In many cases, men have brought samples of milk to the laboratory and preparations have been made from them at once, and shown to them. All of the operations being simple and easily understood, it has been possible to convince even the most ignorant and skeptical farmers that bacteria were real things and that they did not occur in large numbers in milk which was properly cared for.

A copy of the form letter used in reporting the monthly grade has been included in this paper as it gives the rules used in computing these grades.

Mr.

Dear Sir:

The following is a report of the analyses made on the milk delivered by you during the month of

Total number of cans analyzed.....

Number of cans rating as { Good.....
Medium.....
Poor.....

Your monthly rating is.....

Yours truly,

.....
Asst. Bacteriologist.

TABLE 1

Laboratory record prepared from 76 samples of market milk taken by one person from individual 40-quart cans at a single milk station on October 17, 1916

FARM NUMBER	TEMPERATURE MILK		NUMBER OF CANS	NUMBER OF COWS	NUMBER OF CANS RATED AS				NOTES ON SAMPLES	NOTES ON DAIRY
	p.m.	a.m.			Excellent	Good	Medium	Poor		
	°F	°F								
1	54	71	8	40	2	4	2		Cocci, Bact. lactis acidi and rods in medium cans	Excellent stable and equipment
2	57	78	3	18			2	1	Bact. lactis acidi and rods	Good stable and equipment. Men dirty
3	52	68	4	15	4					Fair dairy. Everything kept clean
4	50	72	4	18		4				Good stable and equipment. Fairly clean
5	52	72	4	20		2	2		Large rods and cocci	Fair stable and equipment. Machine milked
6	50	71	4	20		4				Good stable and equipment. Machine milked
7	51	62	3	10	3					Fair dairy. Everything kept clean
8	51	66	2	8	1	1				Fair dairy. Not quite so clean
9	50	58	2	8	1	1				Dilapidated stable and equipment. Fairly clean
10	52	58	4	15		4				Stable poor. Everything dirty
11	48	54	2	8	2					Fair stable and equipment. Very clean
12	46	58	2	7	2					Dilapidated stable and equipment. Dirty
13	52	62	10	50	5	5			Few streptococci in "good" cans	Good stable and equipment. Not clean. Garget
14	51	62	6	48			6		Bact. lactis acidi and cocci	Good stable and equipment. Dirty milking machine
15	52	56	12	60	10	2				Excellent stable and equipment. Clean
16		56	1	12		1				Poor stable and equipment. Clean
17	50	66	2	8	2					Fair stable and equipment. Fairly clean
18		61	1	6		1				Good stable and equipment. Clean
19	48	66	2	6	2					Fair stable and equipment. Clean
Total...76					34	29	12	1		

TABLE 2

Summary, showing the grading of milk delivered between February 1, 1915 and February 1, 1916 to two local milk companies

DAIRYMAN NUMBER	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	TOTAL CANS GRADED	NO. GRADED GOOD	NO. GRADED MEDIUM	NO. GRADED POOR	PER CENT OF TO- TAL GRADED GOOD
1	G	G	G	G	G	G	G	G	G	G	G	G	107	106	1		99.06
2	G	G	G	G	G	G	G	G	G	G	G	G	124	122	2		98.38
3	G	G	G	G	G	G	G	G	G	G	G	G	117	115	2		98.29
4	G	G	G	G	G	G	G	G	G	G	G	G	142	141		1	97.91
5	G	G	G	G	G	G	G	G	G	G	G	G	118	115	3		97.45
6	G	G	G	G	G	G	G	G	G	G	G	G	106	103	3		97.17
7	G	G					G	G	G	G	G	G	59	57	2		96.61
8	G	G	G	G	G	G	G	G	G	G	G	G	152	146	6		96.05
9	G	G	G	G	G	G	G	G	G	G	G	G	216	207	9		95.83
10	G	G	G	G	G	G	G	G	G	G	G	G	122	116	6		95.08
11	G	G	G	G	G	G	G	G	G	G	G	G	118	112	6		94.91
12	G	G	G	G	G	G	G	G					67	63	4		94.03
13	G	G	G	G	G	G	G	G	G	G	G	G	183	169	14		92.35
14	G	G	G	G	G	G	G	G	G	G	G	G	116	107	9		92.24
15	G	G	G	G	G	G	G	G	G	G	G	G	163	150	13		92.02
16	G	G	M	G	G	G	G	G	G	G	G	G	125	116	8	1	91.33
17	G	G	G	G	G	G	M	M	G	G	G	G	331	300	30	1	90.09
18	G	G	G	G	G	G	G	G	G	G	G	M	107	96	11		89.72
19	G	G	G	G	G	G	G	G	M	G	G	G	205	177	27	1	85.50
20	G	M	G	G	G	G	M	G	G	G	G	G	155	134	20		85.35
21	G	G	M	G	G	G	G	G	G	G	G	M	315	275	35	5	84.61
22	G	G	G	G	G	G	M	M	G	G	G	G	146	129	13	4	83.63
23	G	G	G	G	M	G	G	M	G	G	G	G	118	100	17	1	83.33
24	G	G	G	G	M	M	G	G	G	G	G	G	115	97	17	1	82.90
25	G	G	G	G	G	G	G	M	G	G	M	G	396	331	63	2	82.75
26	G	G	G	G	G	M	G	M	G	G	G	G	106	92	11	3	82.14
27	G	G	G	G	G	G	M	G	G	G	G	G	120	100	19	1	81.96
28	G	G	M	G	G	M	M						64	52	12		81.25
29					G	M	G	M	G	G	G	G	66	54	11	1	79.41
30	G	G	M	G	M	M	M	M	G	G	G	G	125	102	17	6	74.45
31	G	G	M	G	G	M	M	M	G	G	M	M	185	135	49	1	72.19
32	G	G	M	G	G	G	M	M	M	M	G	G	332	250	131	1	65.10
33	M	M	G	G	G	G	M	M	M	G	G	G	148	107	31	10	63.69
34	M	M	G	G	G	M	M	M	G	M	M	M	214	148	50	16	60.16
35	G	G	M	M	M	M	M	M	G	M	G	M	207	115	79	13	49.35
36	M							G	M	M	M		68	33	26	9	37.07
Totals													5608	4772	757	79	82.76

Good.—Less than 1,000,000 individual bacteria per cubic centimeter. Practically equivalent to a plate count of less than 200,000 per cubic centimeter. Satisfactory for pasteurization for grade A.

Medium.—More than 1,000,000 and less than 10,000,000 individual bacteria per cubic centimeter. Satisfactory for pasteurization for grade B.

Poor.—More than 10,000,000 individual bacteria per cubic centimeter.

Rules for Computing Monthly Ratings

1. Where a man brings not more than 25 per cent of his milk of "medium" grade he may still be given a "good" rating.
2. Where a man brings not more than 25 per cent of his milk of "poor" grade he may still be given a "medium" rating.
3. In computing percentages, one can of medium milk shall be counted as offsetting 3 cans of "good" milk; likewise, 1 can of "poor" milk as offsetting 3 cans of "medium" milk.

There are a great many interesting and suggestive things which appear in the summary (table 2). Only the most important of them can be referred to here. One of the things which has been noted ever since microscopic methods have been used for routine milk control has been the ease with which it was possible to recognize milks containing long-chain streptococci. Early in this work a record of all samples containing large numbers of these organisms was started. It was found almost at once that such organisms would be frequently found in large numbers in a single can of p.m. milk and in a single can of a.m. milk from the same farm. Usually these organisms were found in among masses of cells. These characteristics, coupled with the well known prevalence of udder infections, led us to suspect the cause at once. Consultation with the farmer failing at times to locate the offending animal, it has frequently been necessary to go to the farms and take samples from each individual cow. These samples were either examined microscopically as soon as the laboratory was reached, or more frequently, they were allowed to stand over night at room temperature before examination. After the cow was located, it was sometimes necessary to return to the farm and take samples from the individual quarters in order to find the exact seat of the trouble. While it has usually been possible to recognize at least some slight indication of inflammation or garget after the cow was found, yet in many cases it was so slight that the farmer cannot be blamed for having saved the milk. In one instance where a case of this sort occurred, the number of bacteria discharged from one quarter of the udder of a single cow contained enough streptococci to give a "medium" rating to a 40-quart can of milk.

Four of the 40 herds from which milk has been sent to these two

milk companies during the past twenty months were found to show troubles of this sort more or less continuously. So far as the records show there are only 8 of the 30 men who have delivered milk throughout this period who have done so without bringing a single can of streptococcus-milk. Out of a total of 9387 cans of milk which have been examined, 309 (3.29 per cent) have shown a predominant long-chain streptococcus flora of more than 1,000,000 individuals per cubic centimeter. Or to put it in another way, 21.4 per cent of all the high count milk received was streptococcus-milk; or one-fifth of all the trouble due to high count milks was caused by udder troubles. Conditions similar to these have been indicated by the work of several previous investigators, (4) but these records are apparently the first which have ever been kept in a way which measures the relative amount of trouble caused in this way. There is no apparent reason why troubles of this sort should be more frequent about Geneva than elsewhere, nor is the amount of clinically evident garget in the herds any more prevalent than elsewhere so far as our experience goes.

Some may question our conclusion that udder infections were the source of the trouble in all cases where streptococci formed an abundant and predominant flora. It is true that the evidence of this fact is all circumstantial but it seems conclusive nevertheless. The most conclusive evidence is furnished by the fact that it has been very easy to find the individual cow in all of the cases, where the matter has been investigated. Streptococci were frequently seen in milks in small numbers where they did not form the predominant flora and where they were not associated with cells. In these instances it is possible that they may have come from feces or other sources.

It is scarcely necessary to point out the importance of these findings to those who are interested in the sanitary control of the public milk supply. It should be noted that Moak (5) has reached somewhat similar conclusions from the results obtained in the routine control of the certified milk of Brooklyn, N. Y. He says, "In working entirely upon a bacterial standard as we do in the production of certified milk, we have come to know

that mastitis is a cause of high counts." "The mastitis causing high bacterial counts in our studies has almost without exception been due to streptococci."

In this investigation only a few samples have been found where our attention has been called to bacteria, other than these streptococci, which were apparently derived from the udder. In some cases, a small micrococcus (possibly a short-chain streptococcus of the "brevis" type) has been seen which was associated with cells and had a distribution in cans of milk similar to that noted in the case of the long-chain streptococci. In one case this was traced back to the individual cow but unfortunately the matter could not be followed up at the time. No samples have been noted which contained bacteria which had the appearance of either the tubercle or of the abortion bacillus though it is quite possible that such samples have been present. Further investigations along this line would reveal many other facts of importance in the control of milk supplies. If more were known concerning the source of the various types of bacteria seen, much help could be given to the farmers in their efforts to produce low count milk. In other respects, the results obtained from the microscopic examination of milk were of equal value to those obtained from agar plate counts and they were used in the same way.

In conclusion it should again be emphasized that no unforeseen or unsurmountable difficulties have been met with in establishing a control of the public milk supply of Geneva by the microscopic method of examination. This system of control appears to have practically all of the advantages of similar systems of control carried out with the agar plate method together with some very important additional ones. In particular these are the chance to control easily and effectively all milk brought in from cows with infected udders, and a possibility of finding many sources of trouble without the necessity of making inspection visits to the farm; this being done by a method which greatly exceeds the agar plate method in simplicity. In view of the comparative work done, there can no longer be any question but that the results are at least as accurate as those secured by

the agar plate-method and there is little question but that a much fairer estimate of real conditions is secured than is ever the case where agar plate counts are carried out by the routine methods ordinarily in use.

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SOME BACTERIOLOGICAL TESTS OF THE MILK CLARIFIER

JAMES M. SHERMAN

Agricultural Experiment Station, State College, Pennsylvania

INTRODUCTION

The present interest in the clarifier as a factor in milk hygiene is shown by the discussions which its use has recently provoked (1). This machine has been taking an increasingly prominent place in the dairy industry during the past few years. It has been used especially in city milk depots, ice cream plants and renovated butter factories where it performs the function of removing visible dirt. At present the milk clarifier is being used to some extent by certified milk producers, many of whom believe that besides the removal of gross impurities the clarification of milk improves its keeping quality, diminishes its bacterial count, and even makes it a more healthful food product. From the point of view of the dealer who is handling milk of ordinary quality it must be acknowledged that the removal of visible dirt is an advantage, but as to whether the producer of high grade milk is justified in going to the expense of installing and maintaining a milk clarifier there may be reason for doubt. It was principally with the view of establishing the merits of the machine from the standpoint of the high-grade milk producer that this investigation was undertaken.

DETAILS OF EXPERIMENT

The milk used in this work was of a grade equal to that of certified milk though not licensed by a medical milk commission. Two milk clarifiers of standard type, both of which are widely used, were tested in this study. They are designated for convenience as "A" and "B." These machines were well cleaned and the working parts thoroughly steamed after use so that the contamination from this source was probably as low as is ob-

tainable under commercial conditions. Tests were made on the effect of the clarifying process on the number of bacteria, the subsequent activity of the organisms, and the keeping quality of the milk.

BACTERIAL COUNT

Samples of milk were taken before and after clarifying and were examined for their bacterial contents. The counts were made by the plate culture method using lactose agar and incubating the plates at 37°C. for forty-eight hours. On twenty-four tests the milk before clarification contained from 1,860 to 11,400 with an average of 4,720 bacteria per cubic centimeter, while the milk after the process contained from 3160 to 13,800 with an average of 7120 bacteria per cubic centimeter. The data obtained are given in table 1.

The increase in the number of bacteria in the clarified milk is of course only an apparent one and is due to the agitation caused by the machine which breaks up the clumps of bacteria, thus increasing the count as determined by the plate culture method. However, this may be considered a disadvantage since, by the methods used in municipal laboratories for the bacterial analysis of milk, clarification increases the apparent number of bacteria and hence to a certain extent lowers the apparent quality of the milk.

ACTIVITY OF ORGANISMS

It might very reasonably be argued that the clarification of milk really improves its bacteriological condition since the increase in the number of organisms is only an apparent one and many bacteria are thrown out with the sediment. On the other hand, it might be contended that the breaking apart of the clumps of bacteria would lead to a more rapid subsequent growth of the organisms remaining. It would be very desirable, therefore, to obtain information concerning the relative physiological activities of the microorganisms in ordinary and clarified milks but such information is difficult to secure with any means we now have at our disposal. The reduction of methylene blue is

probably the most accurate method which may be utilized for measuring the actual vital activities of the bacteria in milk, since practically all of the organisms which develop in milk have at least a slight reducing power for this compound. Reduction tests were made upon the milks in order to throw some light

TABLE 1
Effect of clarification on the bacterial count of milk

TEST NUMBER	MACHINE	BACTERIA PER CUBIC CENTIMETER	
		Before clarification	After clarification
1	A	3,700	6,100
2	A	3,800	6,300
3	A	5,500	8,500
4	A	2,900	6,300
5	A	4,200	6,200
6	A	4,100	6,200
7	A	3,400	7,400
8	A	3,900	6,100
9	A	3,400	4,900
10	A	3,000	4,900
11	A	3,200	6,800
12	A	4,300	9,600
13	B	3,300	5,600
14	B	5,900	7,300
15	B	9,300	13,800
16	B	4,800	7,600
17	B	1,800	3,100
18	B	2,500	3,300
19	B	2,900	3,700
20	B	11,400	13,400
21	B	4,300	6,400
22	B	3,600	4,500
23	B	10,300	13,400
24	B	7,800	9,300
Average.....	A and B	4,720	7,120

on this point. The tests were made by mixing 10 cc. of milk with 1 cc. of a solution of methylene blue (0.05 per cent medicinal methylene blue in physiological salt solution) and incubating at 37°C. until the color disappeared. In making these tests five check samples were run on each milk. Eight such tests were run and in every case the reduction took place sooner in

SOME BACTERIOLOGICAL TESTS OF THE MILK CLARIFIER 275.

the clarified milk. The differences were well marked and indicate that the clarifying process actually stimulates the activity of the organisms contained in the milk. In table 2 are presented the results obtained from these tests.

TABLE 2
Reduction of methylene blue by clarified and unclarified milk

TEST NUMBER	MACHINE	TIME OF REDUCTION IN HOURS	
		Before clarification	After clarification
1	A	21.3	18.1
2	A	14.3	13.6
3	A	19.8	13.9
4	A	17.9	13.6
5	B	13.3	12.5
6	B	18.5	17.3
7	B	20.8	19.1
8	B	17.1	15.6
Average.....	A and B	17.9	15.5

Tests were also made of the rate of acid formation in the milks by placing samples at 37°C. for fifteen hours and then determining the amount of acid produced. Similar trials were made in which the milks were incubated at 10°C. for ten days. The results are given in tables 3 and 4.

TABLE 3
Development of acid in milks held at 37°C. for fifteen hours

TEST NUMBER	MACHINE	PER CENT LACTIC ACID	
		Not clarified	Clarified
1	B	0.264	0.310
2	B	0.268	0.346
3	B	0.337	0.380
4	B	0.257	0.290
5	B	0.283	0.360
6	B	0.228	0.241
7	B	0.234	0.247
8	B	0.257	0.297
Average.....	B	0.266	0.309

TABLE 4
Development of acid in milks held at 10°C. for ten days

TEST NUMBER	MACHINE	PER CENT LACTIC ACID	
		Not clarified	Clarified
1	A	0.571	0.679
2	A	0.574	0.623
3	A	0.551	0.560
4	A	0.562	0.599
Average.....	A	0.565	0.615

As may be seen from table 3 the development of acid at 37°C. was greater in the case of clarified milk in all of the comparisons that have been made. Even at 10°C., at which temperature bacterial growth is greatly retarded, the development of acid was greater in the limited number of tests made. Although it would not be safe to draw the conclusion that clarified milk is of poorer keeping quality than unclarified milk under commercial conditions, it may be quite definitely stated that the clarifier does not enhance the keeping quality.

STREPTOCOCCI

There is a belief among many dairymen that clarification removes certain harmful agents from milk and thus makes it a safer and more wholesome food. This rather hazy impression has doubtless been conveyed through the advertisement of the fact that the clarifier throws out some of the products of inflammation, such as leucocytes or pus cells, which find their way into milk in large numbers whenever any of the milk-producing animals suffer from udder troubles. The impression has been gathered by some that the causal organisms of mammitis are likewise removed by the clarification of milk. That some of the streptococci are removed would appear obvious, but that enough of these organisms are taken out of milk by the clarifier to have any sanitary significance may be doubted. The fresh milk used in this work was found always to contain udder streptococci which are morphologically identical with the streptococcus of

mammitis. Tests were made therefore of the clarified milk for the presence of these organisms. Of fifteen samples taken on as many different days streptococci were found in every case in apparently just as great numbers as in the fresh milk.

DISCUSSION

The work here reported agrees with the more extensive study of Hammer (2) with reference to the bacterial count of milk.

The data presented concerning the activity of the bacteria in clarified and unclarified milk are believed to be of special significance since they show that the breaking apart of bacterial clumps leads to a more rapid subsequent growth. Also it would seem that the ordinary laboratory method of counting bacteria in milk is vindicated. If such methods as cause an increase in the apparent number of bacteria stimulate their activity proportionately the colony count has lost none of its integrity.

The failure of the clarifier to remove streptococci is interesting in view of the rather extravagant claims that have been made for this machine as an eliminator of harmful organisms. That there exists a great difference in the specific gravity of pathogenic and non-pathogenic bacteria has certainly not been established. Even though the harmful types were of greater density many could not be thrown out of milk because of contact with the relatively much larger fat globules. It is well known that a large portion of the tubercle bacilli are thus carried with the cream in the separation of milk. The work of Hammer further shows that less than one-half of the body cells of milk are removed by the clarifying process. The conclusion seems obvious that the clarifier is not of hygienic significance.

If the clarification of milk can not be recommended on sanitary grounds it is pertinent to question whether it is justifiable from the purely economic standpoint. For the certified milk producer it would seem that the process has little to recommend it since visible dirt, other than that removed by the ordinary practice of straining, should not be present to a noticeable extent. The foregoing tests indicate that the process is in fact detri-

mental rather than beneficial when applied to milk of a high grade. It is only to such milks that the conclusions here drawn are meant to apply. For milks of poorer quality the removal of sediment is of obvious advantage; but may it not be possible to remove the visible impurities by a much cheaper process than clarification?

SUMMARY

From the foregoing data it is seen that the number of bacteria in high grade milk as determined by the plate culture method is considerably increased by the milk clarifier. The clarification of milk does not improve its keeping quality; on the other hand it appears that the activity of the bacteria may even be stimulated by the process, as indicated by the methylene blue reduction test and the development of acidity. The clarifying process does not appear to have any hygienic significance as evidenced by its failure to remove streptococci to a measurable extent.

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A SIMPLE SALT TEST

F. W. BOUSKA

American Association of Creamery Butter Manufacturers, Chicago, Illinois

A determination of salt in butter has great commercial value. It shows the uniformity of salting as well as the percentage of salt in each churning. The only way to verify whether the churn over run is as high as it should be commercially and not higher than it ought to be legally is to compare it with the chemical over run. To calculate the chemical over run a knowledge of the percentage of water and salt is necessary. In butter made the usual way it is close enough to assume that the curd is 1 per cent. Again, the question whether a Babcock test of cream should be read according to one authority or another authority is a personal question. To prove the testing of cream by ascertaining whether the butter contains the fat shown by the test is to verify the test by mathematical facts and not by personal opinion. To ascertain the amount of fat in butter by means of creamery facilities, a moisture and salt test are necessary.

After thus emphasizing the value of a salt test I hope to encourage its use by buttermakers by giving a simple method. In it I strive to the utmost to avoid unusual equipment and to use the facilities at hand. It calls for only one piece of apparatus which is not found in every creamery. This is a burette. By using a 5 cc. burette the readings are made directly and are quite accurate. The solutions are used in such small quantities and are so weak that the consumption of chemicals is far less than any other test known to me. This is particularly timely in this period of conservation.

Standard salt solution. Balance a piece of paper on the left pan of the moisture scale. The lower moisture rider can be used to assist in the balancing. Move the rider on the upper beam from the 0 mark to the 10 per cent mark. Add butter salt till the scale balances. The more carefully this is done the more accurate the salt test will be. This, now, is 1 gram of

salt and is 10 per cent of 10 grams of butter, the quantity usually used for the moisture test. Cautiously sweep the salt into a half-pint milk bottle. Fill about half full of distilled water to allow mixing to dissolve. Be careful to dissolve completely. When dissolved add water brimming full at room temperature, and mix by carefully pouring into another bottle. It is not necessary that these bottles hold exactly $\frac{1}{2}$ pint. But it is essential that all the half-pint milk bottles used in this method hold the same quantity. Bottle this solution for future use in checking silver solution. It will keep as long as it lasts.

Silver solution. Again balance a piece of paper on the left pan. This time the upper moisture rider can be used to assist in balancing. Shift the lower rider from 0 to the 20 per cent mark. Put the 10 gram weight on the right pan. Place silver nitrate on the left pan to approximately balance. This is about 12 grams but does not have to be exact. Dissolve the silver in 1 quart of distilled water. Give it plenty of time to dissolve and mix well. Keep in a bottle of amber, blue, or green glass, or stoneware to protect against light. A bottle covered with paper serves well.

Indicator. Dissolve enough potassium or sodium chromate in distilled water to give a yellow color. This is usually a 10 per cent solution, but need not be definite. Sodium chromate ought to be cheaper and potassium bichromate will not do.

Provide a 5 cc. burette with a narrow tube so the $\frac{1}{10}$ marks would be far apart and easily read. The nozzle on the burette should have a fine opening and an easy working pinch cock so drops could be let out easily and under control. A brass or copper nozzle is good. If the wire pinchcock is stiff file the ring thin so it will work easily. Any burette will do but a 5 cc. is more accurate than a larger one.

Standardization. Place the silver in the burette. See that air is expelled out of the nozzle and that the bottom of the meniscus is at 0. By means of a pipette place 9 cc. of the standard salt solution into a white cup or other convenient container. Add enough chromate to give a yellow color. Carefully run in silver out of the burette to the 5 cc. mark. Fill the burette again and

carefully run in silver till a faint brick red color appears and remains permanent. Of course the silver and salt will be well stirred.

If it took 10 cc. of silver to neutralize the salt the silver solution has the correct strength. If 9 cc. of silver neutralized the salt the silver is 10 per cent too strong. Add 10 per cent water (1.6 ounces) by means of a butter color graduate. If 8.3 cc. produced the red color the silver is 17 per cent too strong. Add 17 per cent (2.7 ounces) of water.

The intention of the above directions is to make up an excessively strong preliminary solution of silver. It is easy and accurate to adjust it by adding water. But if the silver solution were weak it would be more difficult to calculate and weigh out the additional quantity of silver. This is further made difficult because the silver is of irregular strength and sometimes weakens with time. Butter salt has a definite strength, does not weaken with age, and is easy to weigh out. The strength of distilled water is 0. Thus it is easy to reduce the strength of a 110 per cent solution to 100 per cent. The 10 cc. representing 10 per cent salt or correct strength enables mental calculation for correction.

If it required 11 cc. of silver to give a brick red color in 9 cc. of standard salt, then the silver is 10 per cent too weak. Add 10 per cent more silver. Since the silver has only a 90 per cent strength 1.3 grams will be required.

In determining salt the chemist does not titrate to a brick red color. But since it is the custom among buttermakers to titrate to a brick red, I recommend it here. The test is correct if the silver is made to show 10 per cent at the brick red point.

After adjusting the silver with water or with more silver verify its correctness by titrating with the standard 10 per cent salt. If 10 cc. of silver is consumed the silver solution is correct.

Determination. Prepare the butter by puddling or working with a spatula, small paddle, paring knife, or teaspoon handle until not even the smallest drops of water are visible. This is a homogeneous mixture any portion of which will analyze the same.

Weigh 10 grams of this butter into a moisture cup or a tea-

spoon, or upon a small piece of parchment paper. Transfer into a half-pint milk bottle by means of hot distilled water poured out of a teapot. If the butter is on a piece of parchment paper it can be placed directly into the half-pint bottle. Melt the butter by shaking in half a bottle of hot water. This dissolves the salt out of the butter. Unless about four minutes is allowed to dissolve the salt the tests of the same sample may vary.

Fill the half-pint bottle brimming full with distilled water. This water for filling need not be hot. Mix by pouring into another bottle. Draw out 9 cc. by means of a pipette before the fat has risen to the top. If the fat has risen to the top the water below will still show practically the same percentage of salt. Titrate with the silver solution to a brick red color. Each cubic centimeter on the burette is 1 per cent of salt and each 0.1 cc. is 0.1 per cent salt.

What remains in the moisture cup after an Irish test has been made on a 10 gram sample may be used for a salt test. This saves again weighing out 10 grams of butter. The residue is transferred into a half pint bottle by repeated washings with hot water. In this case the salt is crusted by the heat and covered with curd and fat. Plenty of time should be given to dissolve it. In a creamery making a few churnings daily this method may be followed: Have as many numbered moisture cups as there are churnings. When the moisture test is finished set the cup aside to be tested at convenience that day or the next day.

By doubling the quantity of silver per quart of water (24 grams) the 17.6 cc. pipette may be substituted throughout for the 9 cc. pipette. Here again the main point is to adjust the silver solution so it would show 10 per cent salt when titrated against the standard salt. The 17.6 cc. pipette will of course consume twice as much silver as a 9 cc. pipette.

After the test is finished the silver in it has not disappeared and may be saved. Pour these test residues into a large bottle or stone jar. The silver will settle into a heavy paste. The clear solution is poured or syphoned off from time to time. In a year or two the accumulated cake of silver chloride is dried

and sold. I have known creameries to recover \$80.00 worth of silver in a year.

My observation is that at least one-tenth of the silver solutions used in creameries are more than 10 per cent incorrect. Nearly all this irregularity arises from depending on the strength of silver nitrate of which a definite quantity is weighed out. Much better results can be expected by basing the test on the definite strength of butter salt.

A PLAN FOR CONTROLLING THE MILK SUPPLY OF THE SMALL TOWN

PERCY WERNER, JR.

From the Department of Dairy Husbandry, University of Missouri

The methods of milk control now in use are three: (I) The control of the sources of production and distribution; accomplished by inspection, usually with the aid of a score card. Under this plan which is widely used no attempt is made to judge the milk itself, the supervision being limited to the methods and equipment used in producing the milk. (II) Control by examining the milk as sold. This method, which is usually limited to use in the larger towns, since the expense of laboratory facilities makes it impractical for the small town, attempts to secure milk of certain specified chemical and bacteriological standards, leaving to the producer the task of marketing a product which will meet the requirements. (III) Safeguarding the consumer of milk by compulsory pasteurization. Seldom is this method the only means of control but it is very generally used for certain grades of milk at least. It of necessity cannot be used in small towns where milk is delivered by the farmers directly.

These three methods are combined in various ways by different cities. In Kansas City, Missouri, for instance, all three are used. Standards, both chemical and bacteriological are set, and regular laboratory analyses are made. The farms and distributing plants are inspected and minimum scores are required. The lowest grade of milk is required to be pasteurized.

The cost of carrying on inspection and laboratory analysis as at present done and the lack of central distributing plants where pasteurization could be done, puts these methods of control out of the reach of the average small town. Before efficient control can be exercised over the milk supply of small towns some method must be devised which will be efficient and at the same time within the reach financially of the small town.

As a result of some experimental work recently carried out

at the Missouri Experiment Station a method of control of the small milk supply has suggested itself to the writer. While making a sanitary survey of the milk supply of St. Charles, Missouri, a series of direct microscopic counts of bacteria was made of milk samples preserved in formalin. These counts made from milk from two to five days old, checked so perfectly with the counts from fresh milk that additional experiments were planned to determine the possibility of making the counts from preserved samples at the Station Laboratory instead of in the field.

The accuracy of the direct microscopic enumeration of bacteria in milk has been sufficiently proved by Breed and the New York Milk Commission (1), as shown by the following quotation from their report by H. W. Conn. "The direct microscopical examination of milk smears by the Breed Method will classify raw milk into grades A, B, and C, with about the same accuracy and much more quickly than the plate method of bacteriological analysis will do." It reveals the number of individual bacteria, both dead and alive and the groups. It will give a count of the leucocytes of milk and will show the presence of streptococci. If dead bacteria will be revealed by this method, then it seems plausible that a bacterial count could be made of milk preserved in formalin. If this should prove to be the case, this method of counting bacteria is subject to a very wide application.

It suggests for instance the possibility of securing a bacteriological control of the milk supply of the small city without the expense in the way of a laboratory and a bacteriologist or an expert inspector. The samples could be collected by a local agent, preserved with formalin and shipped to the Experiment Station or some laboratory where the bacterial count can be made. One central laboratory could thus make the tests of milk from all the small towns of the state. The expense of the testing could be divided among the individual towns. A person who is capable of taking the temperature and representative samples of milk from the dairymen could do all the work that would be required in the town. The sample bottles containing the preservative could be prepared at the laboratory and sent in sufficient numbers to the towns. If the bacterial count could

be thus determined, a satisfactory control of the milk would be possible. Tests for butter fat, water and solids not fat can all be made from a preserved sample. A test for preservative is perhaps the only test ordinarily applied to milk which could not be carried out with such a sample.

THE DIRECT MICROSCOPIC COUNT

The enumeration of bacteria in liquid cultures by means of the direct microscopic count has been used in a variety of ways ever since the time of Lister, Koch and Pasteur. It was first used to determine the approximate number of bacteria in suspension for use as a guide to the proper dilution necessary for plate counting. The first application of the method to milk analysis was made by Dr. F. H. Slack (2) who noticed a relationship between the plate count of bacteria in milk and the number of bacteria in stained centrifuged samples which he was examining for cell and streptococci content.

In 1914 Brew of the Geneva Experiment Station (3) published results of comparisons made at the Station upon the microscopic count of milk by the Breed and the ordinary plate methods, which indicate that milk can be as accurately graded by the one as by the other.

The value of formalin in the preservation of milk is well known. Whether or not it would interfere with the staining of bacteria in milk, had not been determined. That it did not, however, was proved by experiments by the author.

EXPERIMENTAL WORK

It was the purpose of the experiments described to determine whether the addition of formalin to milk would interfere with the successful grading of milk by preventing the staining of the bacteria after preservation for several days. If it should be shown that milk so preserved could be accurately graded according to the bacterial standards set by the New York Commission on Milk Standards, then the use of this method in the grading of milk for the small town as above described, would be

entirely practical. Microscopic counts were made of samples of whole milk of varying sanitary grades after which each sample was preserved in a closed container with formalin in the proportion of 1 part to 500. The containers used were one-fourth pint milk bottles fitted with rubber stoppers and tin clamps. The containers were the same as used in collecting samples in

TABLE 1

Microscopic count of bacteria in milk before and after preservation by formalin

SAMPLE	NUMBER OF BACTERIA BEFORE ADDING FORMALIN	NUMBER OF BACTERIA TWO DAYS AFTER	NUMBER OF BACTERIA FIVE DAYS AFTER
<i>Old milk</i>			
1	580,000	612,000	183,000
2	4,986,000	2,620,000	1,638,000
3	185,000,000	99,500,000	155,400,000
4	6,590,000	10,772,000	
5	2,268,000	1,320,000	
6	1,572,000	1,626,000	
7	2,466,000	2,094,000	
8	4,062,000	1,968,000	
<i>Fresh milk</i>			
9	48,000	12,000	
10	54,000	18,000	
11			
12	48,000	120,000	
13	18,000	6,000	
14	6,000		
15		12,000	

NOTE.—The above results are typical of over 50 samples counted.

the field. These containers have the advantage of being easily filled and cleaned. All air can be excluded and the stopper can be removed by admitting air on one side so that the sample can be agitated without danger of contamination. Counts were made from each of the preserved samples after two to five days with the results as shown in table 1.

DISCUSSION OF RESULTS

A brief discussion of the use of the bacterial count in the grading of milk will assist in making clear the significance of the con-

clusions drawn from the above data. Milk is usually graded into three grades which indicate the degree of cleanliness observed and the temperature regulation in the handling of the milk. Grade A, which according to the standards set by the Commission on Milk Standards by the New York Milk Committee (4), includes all milk containing under 100,000 bacteria per cubic centimeter, is milk of a high quality which has been produced under clean conditions and has been kept cold. Grade B which includes milk containing between 100,000 and 1,000,000 bacteria per cubic centimeter is milk which, though not to be condemned for raw consumption, has not been produced with the greatest degree of care. Grade C, containing over 1,000,000 bacteria per cubic centimeter, is milk so carelessly handled that it is generally considered to be unfit for consumption in the raw state.

The line of distinction between these different grades is very indefinite. The unavoidable error in the counting of bacteria by any method yet devised is such that it is impossible to say for instance, that milk containing only 90,000 bacteria per cubic centimeter is any better than milk containing 110,000. But the methods in use are sufficiently accurate to justify one in the conclusion that there is a marked difference in the sanitary quality of milk containing close to 1,000,000 bacteria per cubic centimeter and milk containing considerably under 100,000.

Examination of the data given above shows that in all but three cases the milk would be put in the same grade whether the count were made before or after preservation considering the grades to be as defined above: Grade A, under 100,000 bacteria per cubic centimeter; grade B under 1,000,000 and above 100,000; grade C, over 1,000,000. The fact that some samples varied as much as 30,000 does not at all interfere with the successful grading of the milk. In the case of the fresh milk where samples are reported as containing no bacteria, this simply means that the number is under 6000, as 6000 is the factor by which each bacterium on the microscopic field was multiplied, in arriving at the total number per cubic centimeter.

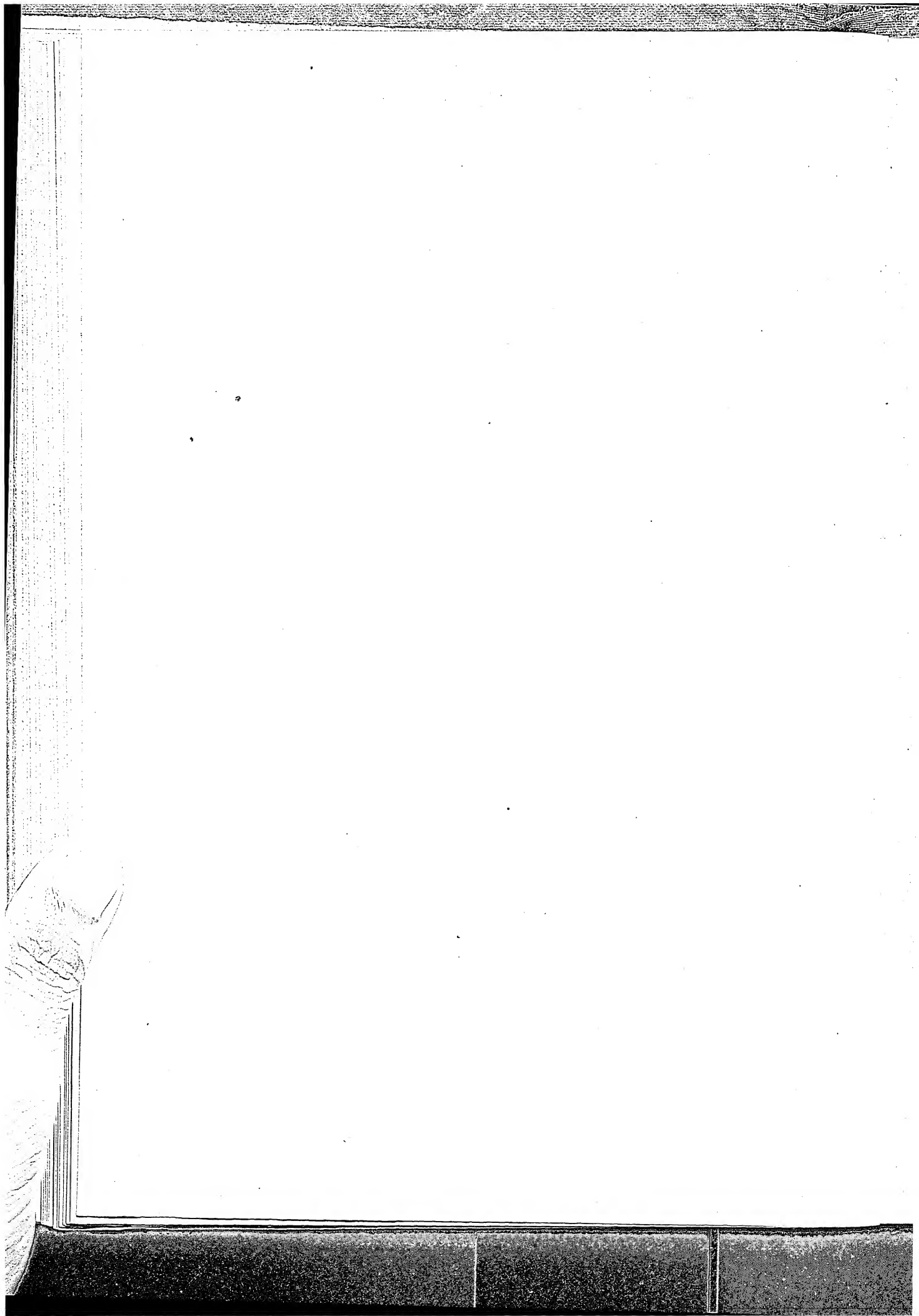
It is not believed that the number of samples tested is suffi-

cient to prove beyond doubt that formalin does not destroy the ability of some bacteria to accept analine dyes after two or five days preservation but it does at least clearly indicate that such is the case.

In the light of this evidence, it would seem to the writer that the laboratory control of the small milk supply could be easily and practically carried on by a central state laboratory where preserved samples could be sent for analysis.

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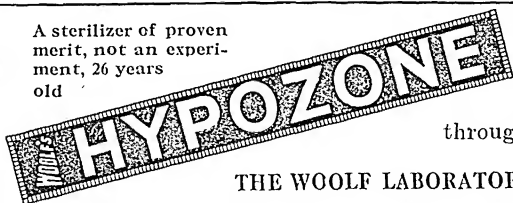
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CLOTTED CREAM

WILFRID SADLER

*Dairy and Bacteriological Laboratories, Macdonald College, Province of Quebec,
Canada*

INTRODUCTION

The counties of Devonshire and Cornwall in England, have for generations been renowned for a particular variety of cream known as "clotted cream," "Devonshire clotted cream," the cream of 2000 years. As long ago as 1791 Twamley in a communication to the "Bath and West Society," says:

From the method used of heating the milk, is produced what is called "clouted cream;" which I suppose should be termed "clotted cream," as the warmth causes the cheese particles to incorporate with the cream, makes it clot, and becomes more mucid or slimy."

In many parts of Canada, and the United States, there are great opportunities existing for the establishment of a new industry; one which would be a sound financial undertaking for the dairyman, and one which would be welcomed by the consumer. In the great fruit producing districts, and in the vicinity of large residential centers, and summer resorts, a constant supply of a first class clotted cream would rapidly create its own demand; would increase the interest of the consumer in the products of the dairy; and would be an industry returning an adequate profit to the farmer or dairyman who undertakes to pioneer and substantiate the production. It is quite feasible to prepare the cream on the farm or at the creamery or factory.

Little data has been published on the preparation of clotted cream, and while some text books, and also official leaflets of the Board of Agriculture, London, have embodied brief descriptions of a general method of procedure, there does not appear to have been any experimental work carried out with a view to the elucidation of a standard system, based on the many methods employed by the various makers. In 1912, I was deputed by the

college with which at that time I was connected—the Midland Agricultural and Dairy College, Kingston, Derby, England—to conduct an enquiry on behalf of the Board of Agriculture into the methods adopted by, and the conditions prevailing among, the makers of clotted cream. Some considerable time was spent among the producers of the cream, and subsequently an exhaustive series of practical experiments was conducted at the college at Kingston.

METHODS IN VOGUE

The method of preparation adopted by one of the large dairy companies in the city of Exeter, Devonshire, is as follows:

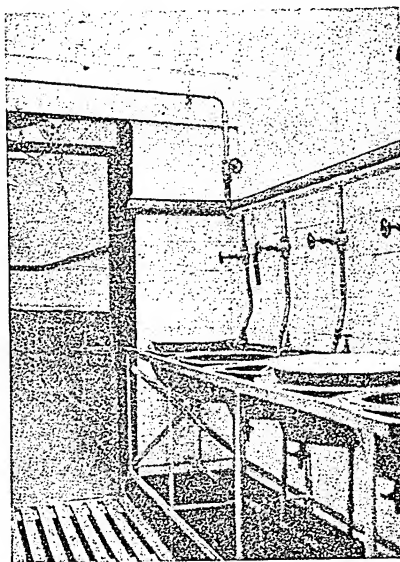


FIG. 1. STEAM SCALDING APPARATUS WITH TWO PANS OF MILK IN POSITION

The cooling room may be seen in the background.

The whole fresh milk is poured into shallow pans and after standing for some ten to twelve hours is scalded. For this purpose the dairies are fitted with long copper troughs to accommodate the water, and with steam connections for the heating; covers made of copper fit on the top, and these are hollowed in

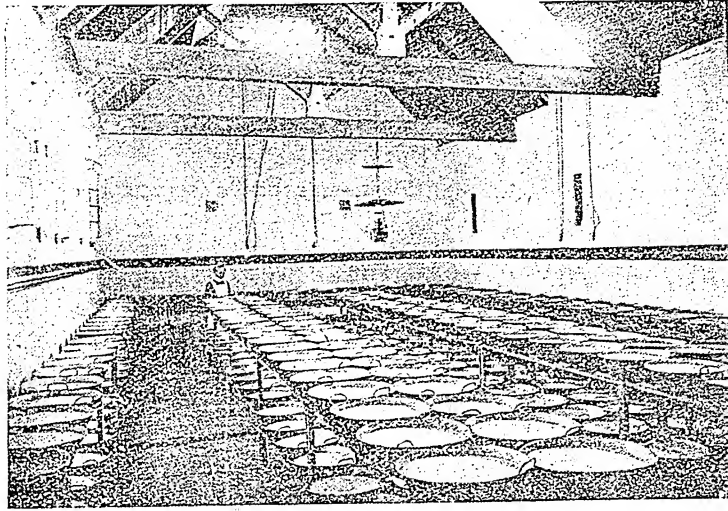


FIG. 2. CLOTTED CREAM MAKING

View of interior of creamery, Aylesbeare, Devon.

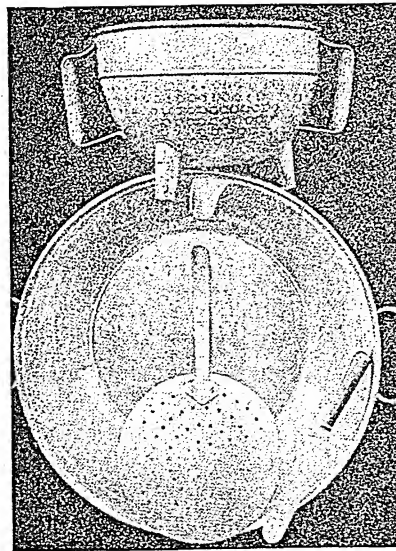


FIG. 3. SOME OF THE UTENSILS USED IN THE PROCESS

Three-legged cream drainer; pan in which milk is set and scalded; skimmer; palette knife.

such a way as will admit of the pans being supported, and at the same time surrounded by the water. The steam is turned on and the water brought to the boiling temperature, when the pans are put on. The temperature of the milk and cream is not usually allowed to go higher than 190° F. and in about fifteen minutes the operation is completed. A thermometer is used, but experienced dairymen often tap lightly the rim of the pan, and if small bubbles rise on the surface of the cream, consider that the scalding is completed. The pans used are of such size as will deal easily with 2 gallons of milk.



FIG. 4. SKIMMING THE CREAM IN A WEST-COUNTRY DAIRY

From the scalding room, the pans are taken to a cooler room, and about twenty-four hours later the cream is taken off by means of specially adapted skimmers: they are long handled skimmers with small perforations, and by means of these the cream is lifted into a metal strainer, the bottom and sides of which are perforated in order to permit of the thinner cream passing away, leaving only the typical thick cream in the vessel. That which passes through the perforation is utilized for butter-making. The cream having been skimmed, is ready for sale at once. In Plymouth, a dairy dealing with the milk of 250 cows adopts

in its essentials, the same method; and the system with slight variations is common to many of the largest producers engaged in the industry.

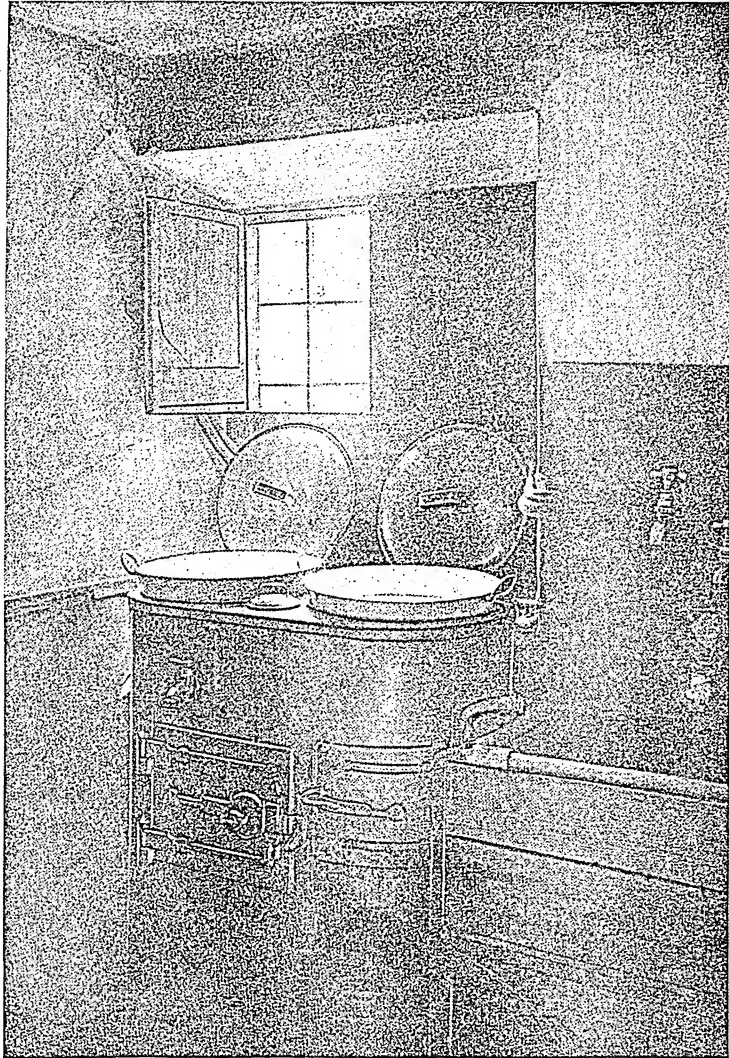


FIG. 5. "FURNACE AND 'COPPER' "

Scalding apparatus as used in a well-known Newton Abbot Dairy.

Another well known maker uses a "copper," the water being heated by a furnace. The temperature of the water in the copper at the conclusion of the process is about 212° F., and the heating is conducted for from thirty to forty minutes. In North Cornwall, there are still to be seen one or two examples of the production of clotted cream where the heating is done by means of peat fuel cut from the moors on the homestead.



FIG. 6. OLD METHOD OF MAKING CLOTTED CREAM

EXPERIMENTS

Before commencing the experimental work, suitable utensils had to be obtained; and having in mind the principal methods adopted by the makers of clotted cream in the west of England, a form of apparatus embodying as far as possible the chief features of the best types in use was designed and fitted up in the

dairies at the college.¹ Briefly, the apparatus consists of a shallow galvanized iron tank raised on strong iron supports, the cover being of block tin with holes to receive the pans of milk. The pans are made of block tin, 20 to 24 inches diameter at the top, 12 to 14 inches diameter at the bottom and 8 inches deep. Water is contained in the tank and the heating effected by means of steam passing through pipes direct into the water, the conducting pipes being arranged in such manner as to avoid vibration. Usually the amount of milk set for creaming was 6 quarts to the pan.

The milk, as fresh as possible, having been poured into the pans, was allowed to stand for twelve to fifteen hours to ensure the rising of the cream. The scalding process was then proceeded with. The temperature of the water having been raised almost to the boiling point, the pans were put on, care being taken that the layer of cream should not be broken. At the beginning of the experimental work the scalding was allowed to take from fifteen to twenty minutes, and the temperature of the milk and cream when removed from the heating apparatus varied from 180° F. to 185° F. After the first four trials, a change was made by scalding from twenty-five to thirty minutes; this was continued throughout and the change was completely justified by the results. During the second half of the experiments, the temperature of the cream and milk at the conclusion of the scalding was 187° F. and it was then that the finest samples of cream were secured. At the conclusion of the scalding, the layer of the cream in the pan is crinkled, and appears as a "blanket" or "head" of cream on the surface of the milk, from $\frac{1}{4}$ to $\frac{1}{2}$ inch thick. The pans were then removed and placed on shelves in a cooling room for from twenty to twenty-four hours. When cool, the blanket of cream was lifted with a skimmer and placed in a perforated strainer; this part of the process requiring careful attention, to avoid impairing the texture of the product.

¹ It has not been possible to obtain a photograph of the actual scalding appliance as used in the experiments. The apparatus was a combination of the appliances shown in figures 1 and 5.

From the strainer, the cream was packed as desired, and at once was ready for consumption.²

ANALYSES

The original milk, the clotted cream, and the resulting scald milk were weighed and submitted to analysis. For the analyses I am indebted to Mr. Alfred Appleyard, M.Sc. (now of the Rothamsted Experimental Station).

TABLE 1 (Percentages)

DATE	SAMPLE	MILK		SCALD MILK		CLOTTED CREAM
		Fat	Total solids	Fat	Total solids	Fat
1912						
July 20.....	1	4.10	13.18	0.80	10.25	59.69
July 21.....	2			1.00	10.41	58.97
July 22.....	3	4.05	13.03	0.80	10.12	56.76
July 23.....	4a	3.90	12.68	0.45	10.00	62.65
July 25.....	5a	3.35	12.61	0.60	10.11	62.61
July 25.....	6a	3.70	12.81	0.75	10.25	64.90
July 26.....	7a			0.75	10.19	66.27
July 28.....	8a	4.80	13.43	1.00	10.13	62.54
July 30.....	9b			0.70	10.41	63.47
July 30.....	9d			0.65	10.32	66.59
August 1.....	10a			0.50	10.00	62.59
August 1.....	10b			0.40	9.68	64.23
August 1.....	11a	4.30	13.24	0.90	10.21	64.10
August 2.....	12a	4.55		0.90	10.16	62.67
August 3.....	13a	4.70	13.53	1.05	10.25	64.72
August 4.....	14a	4.25	12.89	0.60	10.02	64.56
August 5.....	15a	4.50	13.07	0.70	9.97	59.47
August 6.....	16a	4.80	13.84	0.95	10.59	60.33

The average weight of clotted cream worked out at 10.39 ounces cream from 15 pounds milk, or 1 pound clotted cream from 23 pounds of milk.

² The preliminary cooling of the milk, and the cooling after the "scalding" may be hurried by placing the pans in an outer trough or pan through which cold water is continuously running.

Many adaptations of the method will suggest themselves, such being largely dependent upon local circumstances, prevailing equipment, and the quantity of the product it is proposed to place upon any particular market.

A reference to table 1 indicates that the percentage of butterfat in the original milk cannot have any considerable influence upon the percentage of butterfat in the finished cream, owing possibly to the method of skimming which at present prevails. Table 2 gives the complete analyses of the samples of cream; it will be seen that the percentage of butterfat in clotted cream may be as high as 66.59 per cent, the more usual percentage being however from 62 to 64 per cent.

TABLE 2 (Percentages)

Clotted cream

SAMPLE	WATER	BUTTER-FAT	SOLIDS NOT FAT	TOTAL SOLIDS	PROTEIN
1	35.46	59.69	4.85	64.54	3.07
2	33.05	58.97	7.98	66.95	3.00
3	37.29	56.76	5.95	62.71	3.45
4a	32.87	62.65	4.48	67.13	3.51
5a	31.03	62.61	6.36	68.97	3.58
6a	28.10	64.90	7.00	71.90	3.64
7a	27.94	66.27	5.79	72.06	3.19
8a	29.68	62.54	7.78	70.32	2.94
9b	28.15	63.47	8.38	71.85	2.62
9d	27.57	66.59	5.84	72.43	3.58
10a	30.18	62.59	7.23	69.82	3.26
10b	29.06	64.23	6.71	70.94	3.19
11a	30.40	64.10	5.50	69.60	3.26
12a	31.46	62.67	5.87	68.54	3.64
13a	27.87	64.72	7.41	72.13	3.45
14a	29.90	64.56	5.54	70.10	3.39
15a	33.28	59.47	7.25	66.72	3.77
16a	31.74	60.33	7.93	68.26	4.09

QUALITIES OF CREAM

As regards the qualities required in a typical sample of clotted cream, it must be granular in texture; it should be firmer than the thickest of cream obtained from a separator, but not so firm as a freshly made cream cheese; the colour should be golden, not unlike the colour of the butter made from pure-bred Guernsey cows. The cream must not be too wet or "mushy," or if so it ceases to be characteristic; moreover, if too much moisture is present it indicates an excess of scald milk incorporated in the

cream, and the keeping qualities are thereby considerably impaired. The cream must have a nutty taste, and a decided scalded flavour pleasing to the palate.

An important feature of the experimental work to be noticed was the breed of cows from which the milk was produced. The college herd was composed of Dairy Shorthorns; the herds of Devonshire and Cornwall were principally Jerseys, North Devons, South Devons, Guernseys, and various crosses. It has been said that typical clotted cream could only be made in Devonshire and Cornwall. To obtain information on this point, arrangements were made with two well known producers of clotted cream, Mr. A. O. Rowden of Exeter, and Mr. J. Dolbear of Newton Abbott, whereby the experimental samples of cream could be judged. The samples were posted to them as early as possible and would usually arrive some twenty-four to thirty-six hours after skimming.

Extracts from the reports of these gentlemen are as follows:

- 9d. best specimen yet seen granulation all right but lacks the characteristic flavour.
 10a and 10b. samples 10a and 10b are the thing.
 13a. typical after thirty-six hours still very nice and sweet.³
 14a all right and quite typical

These reports would tend to show that breed of cattle and type of pasture have not the predominating influence which hitherto has been credited to them.

BACTERIOLOGICAL PROBLEMS

During the course of the investigation, a number of bacteriological problems suggested themselves; and of these the most important appears to be the explanation of the derivation of that unique flavour so characteristic of the best samples of clotted cream. While the actual scalding process is to a great extent responsible for the specific flavour, there is every reason to believe

³ This would mean about seventy-two hours after packing.

that even before the scalding takes place, the flavour has in a great degree been decided. During the time which elapses between the setting of the milk for creaming, and the scalding, bacterial action is progressing and the various organisms present are exerting an influence upon the flavour of the milk itself. When the scalding begins, the currents which are set up in the milk and cream, tend to distribute the bacteria and bacterial products evenly throughout the whole, and the flavours which are the result of volatilization would probably be taken up and retained by the cream.

The scalding is essentially a system of pasteurization, the efficiency of which depends largely upon the types of bacteria which comprise the original flora of the milk. During the time elapsing between the scalding, and the skimming after cooling, the conditions would be such that the bacteria surviving might exert a further influence upon the flavour and quality of the cream. At the time the work was done, some support was lent to these contentions by the results of certain experiments of which mention is made in the original publication. The scope of the work did not however permit of bacteriological examinations, but the foregoing is included, as a rich field for investigation would appear to have presented itself.

SCALD MILK

Scald milk—the residual milk after the cream has been lifted—was formerly used almost exclusively for the feeding of calves. This by-product however is a commodity of very considerable food value, and in the west of England a profitable business has been established in the selling of the scald milk for human consumption and for cooking purposes. As will be seen—table 1—a high percentage of protein is available and the percentage of butter fat will average about 0.75 per cent.

SUMMARY

1. Enquiries have been conducted on behalf of the Board of Agriculture as to the methods adopted by the producers of 'clotted cream' in the counties of Devonshire and Cornwall.

2. Experiments have subsequently been undertaken at the Midland Agricultural and Dairy College, Kingston, Derby.

3. The results of these experiments thus far, tend to show:

a. That provided a suitable system be adopted and reasonable care be taken in management and manipulation, clotted cream having the typical and characteristic properties can be produced in any district.

b. That while a rich milk is preferable, it is not at all essential for the production of characteristic clotted cream to have only the breeds of cattle favoured by the producers in Devonshire and Cornwall.

c. That the flavour and keeping properties of the cream are problems of a bacteriological nature.

4. "Scalding" for twenty to thirty minutes with a final temperature of 187° F. proved to be a satisfactory procedure.

5. One pound of clotted cream was produced from 23 pounds of milk.

6. The average percentage of butterfat in the clotted cream was 62 to 64 per cent.

7. The average butterfat content of the scald milk was 0.75 per cent.

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①

EXPERIMENTS ON DETERMINATION OF COW MANURE IN MILK; MOISTURE CONTENT AND SOLUBILITY OF COW MANURE¹

GEORGE BARKLEY TAYLOR

Dairy Division, Market Milk Section, United States Department of Agriculture

A series of experiments was conducted on cow manure from the experimental farm at Beltsville, to determine primarily whether the manure in unstrained milk can be measured quantitatively by chemical methods. A method was found which gave good results provided the original quantity of manure present was fairly large. For average milks, however, this chemical method is impractical on account of the fact that while manure is always present, it is as a rule in such small amounts that it cannot be measured chemically.

It was found that a series of disks containing known amounts of manure could be made which will give fairly accurate results when compared with the sediment from milk after using the sediment tester, by means of a modified method. Since accurate determinations can be made only with unstrained milk, and since all market milk is strained there seems to be no simple practical method of determining the amount of manure present in milk. Along with this work, other experiments were made to determine moisture and solubility in water and milk of fresh and dry manure.

Composite samples of manure were collected at different times, covering a period of two months. The cows were fed bran, corn meal, cottonseed meal, and corn silage. The manure, fresh, was a heterogeneous mass, consisting of short straw and fiber, pieces of corn, mixed with a wet dark mass. The samples were well mixed, but not ground.

The moisture was determined by drying the fresh moist sample for five hours in an air oven at 98 to 100°C. The results together

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with the approximate amounts taken for the determinations are shown below:

	<i>per cent</i>
	{ 84.24
	{ 82.32
	{ 83.89
Lot, using 5 grams wet material.....	{ 83.93
	{ 83.72
	{ 83.95
	{ 81.85
	{ 81.48
Lot, using about 2 grams wet material.....	{ 82.11
	{ 82.08
	{ 82.61
	{ 82.65
Lot, using from 0.5 gram to 6 grams wet material.....	{ 83.22
	{ 81.04
	{ 82.00
	{ 83.64
	{ 82.80
Lot, using about 1 gram wet material.....	{ 82.90
	{ 82.99
	{ 82.76
Lot, using about 0.5 gram wet material.....	{ 82.36
	{ 83.53
Lot, using about 2 grams wet material.....	{ 84.60
	{ 80.63
Lot, using about 2 grams wet material.....	{ 80.33
Lot, using about 2 grams wet material.....	84.00

The average of twenty-six determinations was 82.76 per cent moisture in the fresh manure. This would leave an average of solid matter in the manure, 17.24 per cent.

The moisture content of the air-dried manure was also made. These determinations were made by drying in an air oven, 98 to 100°C., composite samples of manure which had been allowed to air dry at room temperature.

The results were as follows:

	<i>per cent</i>
	5.79
	5.91
Moisture.....	5.73
	5.86
Average.....	5.43
	5.74

This would leave for the air-dried manure a solid content of 94.26 per cent.

SOLUBILITY OF MANURE IN WATER

The dried manure solids were treated with distilled water; first, by transferring the material to a weighed filter and washing with water to clearness; secondly, by allowing the material to soak in water from one hour to eighteen hours and then filtering through either a weighed filter paper or a weighed cotton disk. The results obtained by these different methods are so nearly alike that the figures are combined to get the averages:

Solubility of solid matter in manure after drying to constant weight

CALCULATED ON WET BASIS		CALCULATED ON DRY BASIS	
Insoluble	Soluble	Insoluble	Soluble
<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
14.28	1.48		
14.20	1.56	90.14	9.82
16.15	1.53	91.38	8.62
14.27	1.84	88.58	11.41
15.73	2.16	87.93	12.07
15.82	2.10	88.22	11.78
Ave., 15.07	1.78	89.25	10.74

Summarizing the results thus far obtained we get:

For fresh manure (averages)

	<i>per cent</i>
Moisture.....	82.76
Solids	
Water soluble.....	1.78
Water insoluble.....	15.07

For air dry manure (averages)

Moisture.....	per cent 5.74
Solids	
Water soluble.....	10.12 (94.26 × 10.74)
Water insoluble.....	84.14 (94.26 × 89.25)

From these results we conclude that with a water solution of fresh manure, 84.54 per cent ($82.76 + 1.78$) will be in solution, leaving 15.07 per cent insoluble; while with an air dried manure, 15.86 per cent ($5.74 + 10.12$) will go into solution, leaving 84.14 per cent insoluble.

SOLUBILITY OF MANURE IN MILK

The method of determining solubility of manure in milk had to be varied from that used in determining solubility of manure in water on account of the fat and other solid matter in milk which might remain on the filter. The dried material after soaking in milk was transferred to a Gooch crucible with a cotton disk, washed with warm water followed by ether. Details of this method are given further on.

The dried manure was lumpy. These lumps were broken up but were not pulverized.

The results are as follows:

Solubility, in milk, of solid matter in manure dried at 100°C., for five hours

CALCULATED ON WET BASIS		CALCULATED ON DRY BASIS	
Insoluble	Soluble	Insoluble	Soluble
<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
16.99	1.16	93.63	6.37
17.26	1.26	93.20	6.80
15.19(av.-3)	0.94(av.-3)	94.22(av.-3)	5.78(av.-3)
15.71	0.65	96.02	3.98
16.41	0.79	95.44	4.56
16.98	0.66	96.34	3.66
15.20	1.27	92.37	7.63
Ave., 16.25	0.96	94.46	5.54

Summarizing the results, we obtain the following:

<i>For fresh manure (averages)</i>	
Moisture.....	<i>per cent</i> 82.76
Solids	
Soluble in milk.....	0.96
Insoluble in milk.....	16.25

<i>For air dried manure (averages)</i>	
Moisture.....	<i>per cent</i> 5.74
Solids	
Soluble in milk.....	5.22
Insoluble in milk.....	89.04

From these results we can say that approximately 83.72 per cent of fresh manure is soluble in milk, leaving 16.25 per cent insoluble. On the other hand, with air dried manure, 10.96 per cent will go into solution in milk, leaving 89.04 per cent insoluble.

Comparison of the solubility of manure in water and milk shows the following results:

	SOLUBILITY IN	
	Water	Milk
	<i>per cent</i>	<i>per cent</i>
Fresh manure (82.76 per cent water).....	84.54	83.72
Air dried manure (5.74 per cent water).....	15.86	10.96

In general, manure in whatever condition is less soluble in milk than in water. Nearly all of the above determinations were made after allowing the foreign material to remain in contact with the milk or in water in bottles over night. Experiments show very little difference in the results by allowing the manure to remain in the milk or water different periods of time.

SUSPENDED FOREIGN MATTER IN MILK

Experiments were made to determine whether manure in bottled milk settled to the bottom of the bottle. Manure, both fresh and air dry, was added to pint bottles of milk and the material allowed to settle over night. A layer about 1 inch from

the bottom of the bottle was siphoned off, the sediment being collected on a Gooch crucible.

	RESIDUE ON BOTTOM	SUSPENDED MATTER
	<i>per cent</i>	<i>per cent</i>
Wet manure.....	88.25	11.75
	90.78	9.28
Air dried manure.....	94.97	5.03
	89.95	10.05
Average.....	90.99	9.02

These results vary considerably, but they prove conclusively that all of the sediment in milk is not visible—that some of it remains suspended in the liquid. It may be stated that approximately 90 per cent of the foreign solid matter in milk settles to the bottom of the bottle where it may be seen.

WORK ON CHEMICAL METHODS TO DETERMINE SEDIMENT IN MILK

Experiment 1

- a. Pint bottle of milk, containing no sediment, filtered cold, through dried, weighed cotton disk in copper sediment tester; not washed, dried and weighed. Gain in weight (milk residue), 0.0630 gram.
- b. Repeated washing with 50 cc., water, gain in weight (milk residue), 0.0360 gram.
- c. Repeated washing with 100 cc. water, gain in weight (milk residue), 0.0320 gram.
- d. Repeated washing with 200 cc. water, gain in weight (milk residue), 0.0370 gram.

Experiment 2

- a. Pint bottles of clean milk to which were added 0.5 gram, dry extracted manure; mixed; allowed to stand; filtered cold through dried, weighed cotton disk in copper sediment tester, washed with 200 cc. water; dried. Gain in weight over original material (0.5 gram) (milk residue), 0.1460 gram, 0.1180 gram, and 0.1320 gram.
- b. Repeated, following washing with 200 cc. water and 25 cc. ether. Average increase in weight over original weight, 0.0080 gram.
- c. Repeated, using only 0.1 gram dry extracted manure, washing

with 200 cc. water and 25 cc. ether. Average loss in weight under original weight, 0.0092 gram.

Experiment 3

Different amounts of dry extracted manure were added to pint bottles containing clean milk. This was set aside over night. The material was warmed to about 45°C. (113°F.), filtered through dried and weighed cotton disks in weighed nickel Gooch crucibles, using slight suction.

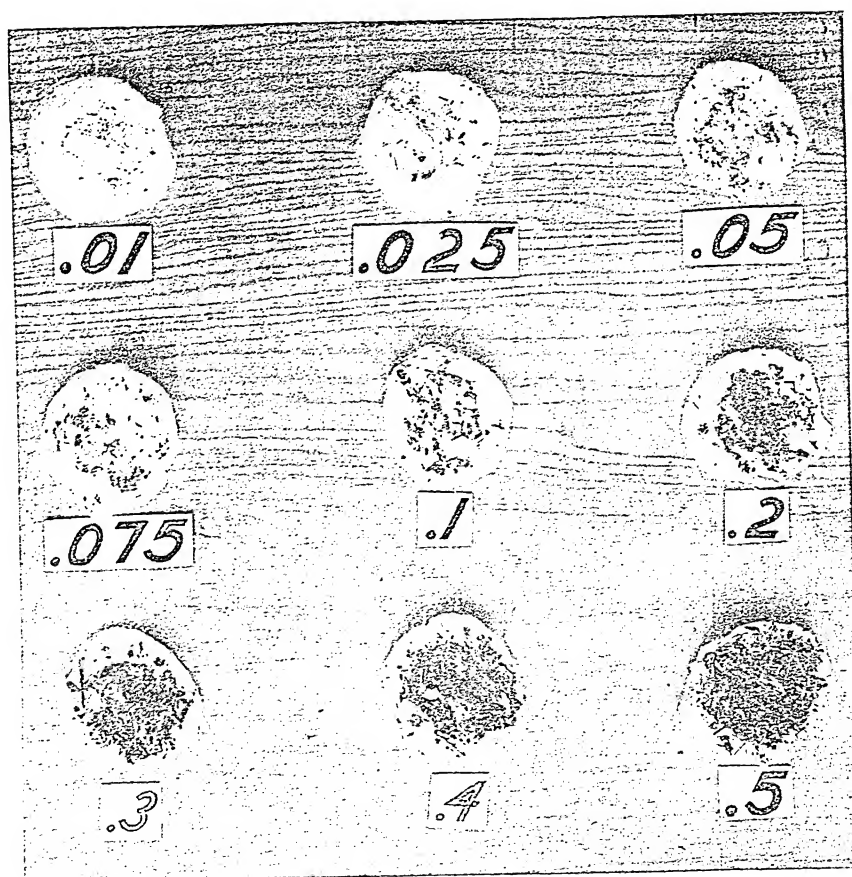
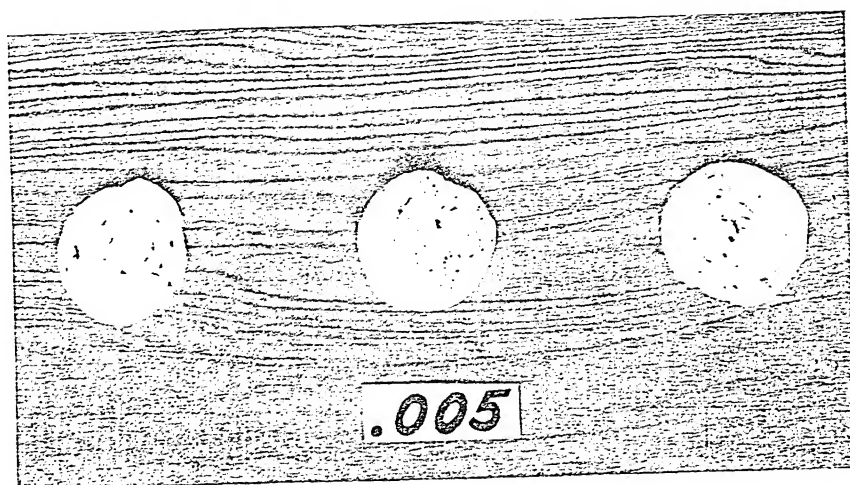
This material was washed with 200 cc. warm water, followed by 25 cc. ether, dried and weighed. Dry manure was used, but this was calculated to wet manure, using moisture factor of 82.8 per cent.

SAMPLE	USED		RECOVERED	LOSS OR GAIN
	Dry	Wet		
	grams	grams	grams	grams
(a).....	0.0860	0.5000	0.0810	0.0050 loss
(b).....	0.0688	0.4000	0.0675	0.0013 loss
(c).....	0.0516	0.3000	0.0480	0.0036 loss
(d).....	0.0344	0.2000	0.0320	0.0024 loss
(e).....	0.0172	0.1000	0.0275	0.0103 gain
(f).....	0.0129	0.0750	0.0170	0.0041 gain
(g).....	0.0086	0.0500	0.0095	0.0009 gain
(h).....	0.0043	0.0250	0.0070	0.0027 gain
(i).....	0.0017	0.0100	0.0070	0.0053 gain

Sample (e) is clearly off, and it is left out of the average. The amounts recovered vary from 5 mgm. below to 5 mgm. above the amounts used, the average loss and gain almost checking each other. It can be considered, therefore, that the above method is accurate to within 5 mgm.

The method outlined above (experiment 3) can be used only when milk contains more than 0.1 gram of wet (fresh) manure, as the error of 5 mgm. is too great when less manure is present. In actual practice, manure is seldom found above 0.1 gram in milk, consequently, this method is inapplicable for average amounts of manure present in milk.

Twenty-eight samples of unstrained milk were examined by this method. Quantitatively, they varied from 2 to 20 mgm. Physically, they showed no such variation, as there seemed to

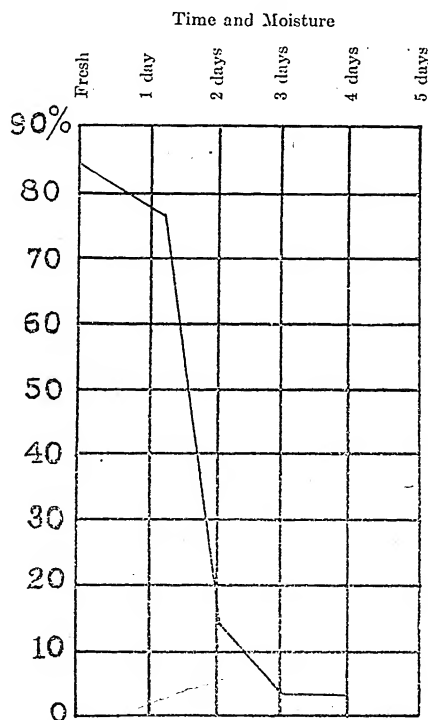


SHOWING VARYING AMOUNTS OF DIRT IN UNSTRAINED MILK.

be only a trace of manure in each disk. Compared with standard disks, there are less than 0.8 mgm. of manure, being one-third to one-twenty-fifth of the amount found quantitatively. A series of twelve cotton disks were prepared, showing quantities of wet manure from 0.5 gram to 0.005 gram. The increase in amounts was well shown on these disks and they were photographed. It is thought that they will, in a measure, indicate the amount of manure present in unstrained milk. Clean unstrained milk shows only traces of residue that might be laid to manure. It does contain cow hairs and white flakes which appear to be epidermis cells from the udder.

These disks show amounts of manure, calculated to a wet basis, placed in milk and filtered through cotton disks. The residues were washed with 200 cc. of warm water followed by 25 cc. ether.

The following diagram shows the rate in percentage of moisture and time of manure spread out to air dry:



Manure present in unstrained milk in quantities greater than 0.1 gram may be fairly accurately determined by filtering through a cotton disk and washing with 200 cc. water, followed by 25 cc. ether. Both the milk and the water should be warmed to about 45°C. before filtering. The disk should be dried and weighed before and after filtration. Manure present in unstrained milk in smaller quantities may be determined by filtering through cotton disks and comparing with standard prepared disks containing known amounts of manure.

It must be admitted that the results obtained are only approximate for dairy cow manure. However, considering the heterogeneous composition of this material the averages found are believed to represent the facts fairly well.

SUMMARY

The moisture in the cow manure examined averaged nearly 83 per cent. Air dry manure contains about 6 per cent of moisture; 5 per cent of the remaining solid matter is soluble in milk. This would indicate that only 11 per cent of dry manure dissolved in milk, 6 per cent of this being water.

Nearly 85 per cent of fresh cows' manure will dissolve in milk, 83 per cent of this being moisture. Manure in whatever condition is less soluble in milk than in water. Of the manure present in bottled milk, 91 per cent will be visible on the bottom of the bottle, leaving 9 per cent of foreign matter in suspension.

PRELIMINARY NOTE ON CERTAIN CHANGES IN SOME OF THE NITROGENOUS CONSTITUENTS OF MILK CAUSED BY BACTERIA

G. C. SUPPLEE

Department of Dairy Industry, College of Agriculture, Cornell University

The data presented herein is the result of a preliminary investigation on certain quantitative changes in the nitrogenous constituents of milk caused by bacteria before any change in the physical appearance of the milk is evident. The plan of the analyses was one of fractional precipitation by various precipitating reagents and the subsequent determination of the nitrogen in each of the fractions.

METHODS

Bacteriological. Accurately measured 50 cc. quantities of sterile skimmed-milk were placed in glass stoppered bottles and inoculated with a small amount of a watery suspension of the specific organism. The inoculated milk was then incubated at 30°C. for twenty-four hours. The number of organisms per cubic centimeter was determined by the plate method immediately after inoculation and at the end of the incubation period just prior to the beginning of the chemical analysis.

Chemical. The following plan of analysis was applied to each lot of milk just before inoculation and again at the end of the incubation period:

The total nitrogen was determined by the Kjeldahl method, a 5 cc. sample being used. Fiftieth normal sodium hydroxide was used for titrating the excess tenth normal acid.

The casein was precipitated by diluting 10 cc. of the sample with 70 cc. of distilled water and precipitating with 1.5 cc. of 10 per cent acetic acid at 40°C. The precipitate after settling out was filtered upon an ammonia-free filter paper until the filtrate was clear. The casein was then washed with acidified water until the filtrate and washings amounted to about 100 cc. The

filter paper was then transferred to a Kjeldahl flask and the nitrogen determined as for total nitrogen.

The filtrate obtained from the casein fraction was used for the precipitation of the albumin. About one gram of sodium chloride and one or two drops of phenol-phthalein were added to the filtrate and the mixture slowly heated to the boiling point and held for two minutes. During the heating concentrated sodium hydroxide was added until the mixture was neutral or slightly alkaline as indicated by a faint pink color. The same degree of color was maintained during the boiling period. This precipitation of the lactalbumin in neutral solution as recommended by Van Slyke and Hart (1902) gave satisfactory results in fresh milk but in many instances where marked decomposition of the casein had taken place a complete precipitation could not be obtained (5). Due to this fact a 10 per cent solution of colloidal iron (dialyzed ferric hydroxide) was used in all determinations. While the mixture was still hot 4 cc. of the colloidal iron was added drop by drop and the mixture gently shaken after each addition. The precipitate upon settling was filtered, washed and the nitrogen determined as noted above. The colloidal iron precipitated any albumin remaining in solution, it also brought down any other colloidal material which was present (1). As will be shown later this fraction contains other substances than the lactalbumin. The method however, gave comparative results which were desirable for this work.

Non-colloidal nitrogenous materials precipitated by phosphotungstic acid were included in the next fraction. This reagent will precipitate from acid solution; peptones, nitrogen bases including ammonia and the diamino acids (2). To the filtrate from the albumin fraction 0.5 cc. of 50 per cent sulphuric acid was added and then phosphotungstic acid drop by drop until no more precipitate appeared. The precipitate was allowed to settle out for twenty-four hours and then it was filtered upon a small ammonia-free paper. The filter paper and precipitate were dried in the air and transferred to a small evaporator where exactly 6 cc. of chemically pure concentrated sulphuric acid were added. The acid and paper were brought into intimate

contact by constant use of the stirring-rod until digestion had gone far enough to give a uniform mixture. An aliquot part of this mixture (2 cc. measured with an Oswald pipette) was used for the nitrogen determination by the Folin-Farmer microchemi-

TABLE 1

Table showing the changes in nitrogen content of the various fractions caused by different species of bacteria. Results are expressed as milligrams of nitrogen per 100 cc. of milk

ORGANISM	TOTAL NITROGEN	CASEIN NITROGEN		ALBUMIN FRACTION NITROGEN		PHOSPHOTUNGSTIC ACID FRACTION		AMMONIA NITROGEN		SOLUBLE NITROGEN OTHER THAN AMMONIA	
	mgm.	mgm.	per cent	mgm.	per cent	mgm.	per cent	mgm.	per cent	mgm.	per cent
Sterile.....	481.34	422.37	87.6	42.54	8.81	2.02	0.41	2.45	0.50	11.60	2.67
Bact. lactis acid.....	481.34	408.82	84.0	46.94	9.70	1.40	0.29	2.46	0.51	21.72	5.50
Mic. albidus.....	481.34	422.91	87.8	40.31	8.16	2.29	0.47	2.92	0.60	12.91	2.97
Sterile.....	503.89	442.33	87.7	36.28	7.19	2.09	0.41	1.73	0.37	21.46	4.25
Ps. liquefaciens.....	503.89	446.90	88.7	35.16	6.97	2.12	0.41	1.53	0.30	18.18	3.63
B. lactis viscosus.....	503.89	438.85	87.0	42.12	8.35	2.91	0.57	1.70	0.33	18.31	3.67
B. mycoides.....	503.89	417.80	82.9	55.48	11.01	4.87	0.96	7.74	1.53	18.00	3.60
Acid peptonizer..... (species unknown)	503.89	435.93	86.5	41.61	8.25	2.00	0.39	3.00	0.59	21.35	4.26
Bact. bulgaricum*.....	503.89	430.14	85.3	30.31	6.01	6.11	1.21	1.69	0.33	35.64	7.09
Sterile.....	457.02	396.17	86.7	53.25	11.65	1.90	0.41	1.01	0.22	4.69	1.04
B. coli communior.....	457.02	394.55	86.3	44.21	9.67	2.25	0.49	8.74	1.91	71.60	1.60
Bact. aerogenes.....	457.02	391.34	85.6	48.89	10.69	1.72	0.37	10.73	2.10	4.27	1.90
Sterile.....	495.51	435.65	87.9	37.40	7.48	1.88	0.37	0.36	0.07	0.34	4.17
B. prodigiosus†.....	495.51	383.62	76.8	64.25	12.98	12.01	2.42	1.33	0.26	24.22	7.54
Ps. pyocyaneus.....	495.51	398.76	80.5	56.02	11.10	7.17	1.44	1.99	0.40	31.30	6.57
Sterile.....	462.45	390.69	84.5	50.46	10.90	1.55	0.33	1.47	0.31	37.57	3.98
B. subtilis.....	462.45	288.96	62.5	133.36	28.81	9.77	2.11	2.15	0.46	18.28	6.14

* This organism was incubated at 37°C. The milk was coagulated at the time of analysis.

† The milk was coagulated at the time of analysis.

cal method (3). The ammonia was aspired into hundredth normal acid and the excess acid titrated with five hundredth normal alkali. Methyl-red was used for the indicator.

The free ammonia was determined in 4 cc. quantites of milk

by the microchemical method of Folin and MacCallum (4). In this determination as in the above the weak standard acid and alkali were used instead of the colorimetric method.

The soluble nitrogen compounds other than those included in the foregoing fractions were calculated by difference.

CHEMICAL DATA

All determinations were made in duplicate and the necessary checks made upon the various reagents and materials used.

TABLE 2

Table showing the number of organisms before and after incubation, the number of generations produced by each species and the average number of organisms existing for the twenty-four hour period

ORGANISM	NUMBER OF ORGANISMS PER CUBIC CENTIMETER		NUMBER OF GENERATIONS	AVERAGE NUMBER ORGANISMS PRESENT FOR THE TWENTY-FOUR HOUR PERIOD
	Before incubation	After incubation		
1. Bact. lactis acidi.....	18,000	390,000,000	14.32	54,500,000
2. Mic. albidus.....	650,000	20,000,000	4.92	8,000,000
3. Ps. liquefaciens.....	1,850,000	360,000,000	7.94	90,400,000
4. B. lactis viscosus.....	16,700,000	100,000,000	2.49	73,600,000
5. B. mycoides.....	220,000	25,000,000	6.77	7,350,000
6. Acid peptonizer.....	5,350,000	540,000,000	6.57	163,600,000
7. Bact. bulgaricum.....				
8. B. coli communior.....	11,000,000	710,000,000	6.00	234,800,000
9. Bact. aerogenes.....	420,000	1,270,000,000	11.47	221,400,000
10. B. prodigiosus.....	6,400,000	520,000,000	6.27	164,800,000
11. Ps. pyocyaneus.....	2,680,000	500,000,000	7.45	133,900,000
12. B. subtilis.....	150,000	50,000,000	8.30	12,000,000

Table 1 gives the averages of the net duplicate determinations from the above procedure. The various lots of sterile milk are samples taken at different times.

BACTERIOLOGICAL DATA

The chemical data gives the relative change in nitrogen content of the various fractions but does not truly indicate the fermentative capacities of the various organisms. The following bacteriological data is included in order to give an idea as to the

relative number of organisms responsible for the changes indicated in table 1. In this paper no attempt will be made to correlate chemical decomposition with the bacterial content of a marketable milk. Such information must remain for future study.

In table 2 the number of generations and the average number of organisms existing for the twenty-four hour period were calculated by application of the following formulae:

- (1) Formula for calculating the number of generations.

$$N = \frac{\text{Log } (B/A)}{\text{Log } 2}$$

N = Number of generations

A = Initial count

B = Final count

- (2) Formula for calculating the average number of organisms existing for the twenty-four hour period.

$$P = \frac{(B \times R) - A}{(R - 1) \times N}$$

P = Average number of organisms existing for the twenty-four hours

$R = 2$ (Ratio of the progression)

N = Number of terms in the progression. (Number of generations)

A = Initial count

B = Final count

COMMENTS

In many instances the changes in the nitrogen content of the various fractions are so slight that they do not merit comment at this time. Many of the results however, are beyond the realm of experimental error and it is believed that they are worthy of attention. A study of table 1 will reveal the following general results:

All organisms tested except two cause a decrease in the casein fraction and in most cases this decrease is more marked with those organisms known to possess extreme proteolytic proper-

ties. Since each determination was made in the same manner, the results show relative changes by each of the cultures which have altered the precipitation of casein with dilute acetic acid.

The albumin fraction contains not only lactalbumin but any other colloidal material which may have been present. This is evident from the fact that with seven of the organisms there is an increase in this fraction. It is also apparent that in those cases where the albumin fraction has increased the casein fraction has materially decreased although the increase in the former is not equal to the decrease in the latter. This would seem to indicate that a part of the casein remained as a colloidal proteose which was not precipitated by acetic acid but was brought down by the colloidal iron. The data obtained does not show to what extent the albumin itself has been acted upon in such cases. The results obtained from the five remaining organisms show a decrease in the albumin fraction and in four instances there is little or no decrease in the casein fraction. This would seem to indicate that these species could attack the albumin more readily than the casein.

The changes in the nitrogen content of the three lower fractions are of particular interest inasmuch as they include compounds low in the scale of protein decomposition. It is quite possible that the substances in two of these fractions are responsible for some of the undesirable effects of bacterial action on milk, inasmuch as some of the organisms showing the most marked changes are commonly found in milk in appreciable numbers.

Although the bacterial content of the milks used for these analyses was far in excess of that found in a marketable product, the changes produced under these conditions serve as a preliminary basis upon which further work is contemplated.

ACKNOWLEDGMENT

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TALLOWY BUTTER—ITS CAUSES AND PREVENTION

O. F. HUNZIKER AND D. FAY HOSMAN

Research Laboratory of Blue Valley Creamery Company, Chicago, Illinois

RANCIDITY AND TALLOWINESS

Rancidity and tallowiness are flavor and odor defects of butter which are generally attributed to the decomposition of the butterfat. Owing to the fact that the scientific investigator generally is not and does not presume to be, a butter judge, and therefore is not in a position to recognize and describe flavor defects of butter such as the butter expert knows them, no sharp distinction has heretofore been made in the description of experimental results dealing with these two butter defects. This has often resulted in the use of the terms rancidity, and tallowiness as synonyms. This confusion has been further aggravated by the fact that both of these flavor defects are often found in the same piece of butter. The inaccurate use of these terms is unfortunate, inasmuch as it has led to misleading interpretation of the causes of the defects which they describe, and has rendered difficult successful efforts towards their prevention.

The bulk of experimental data available shows conclusively, that rancidity and tallowiness are the result of entirely different causes, rancidity being the result of hydrolysis and tallowiness being caused through oxidation. Under ordinary conditions, the hydrolysis leading to rancidity, is accomplished only by the action of ferments, while the oxidation is strictly a chemical action.

Jensen (1) and other investigators have shown that certain species of bacteria, and molds when inoculated into butter cause the butter to become rancid. The development of rancidity in these cases was accompanied by a marked increase in the acid value of the fat, showing that the rancidity was due to the formation of free fatty acids by hydrolysis of the fat.

Ritsert (2) demonstrated that these same organisms, when inoculated into pure butterfat, do not produce rancidity. This he

found to be due to the fact that the microorganisms failed to develop and rapidly disappeared, evidently because pure butterfat lacks the necessary food elements, salts, sugar and protein, for bacterial growth. On the other hand, Duclaux (3), by the exposure of pure butterfat to air and light, obtained tallowy flavor and odor, in the fat. The development of tallowiness occurred without change in the acid value, but with a decrease in the iodine absorption number.

These results, which have been amply corroborated by other investigators can leave no doubt as to the difference between tallowiness and rancidity, and they definitely show that the solution of the causes and prevention of tallowy butter deals with problems foreign to those problems which have to do with rancidity.

TALLOWY BUTTER

Description of butter defect. Butter which is termed tallowy has a distinct taste and odor of spoiled tallow and usually is bleached in color, or entirely white. Very old tallowy butter may change to a pinkish brown color. Tallowiness is a defect which renders butter utterly unfit for the market.

Occurrence of tallowy butter. Butter may and frequently does develop a tallowy flavor and odor and a white color within a few weeks of manufacture, though this defect usually requires from three to six weeks to become pronounced. Tallowiness is not a usual cold storage defect of butter. In cold storage, butter hardly ever goes tallowy. This defect develops primarily in butter laying in the stores and exposed to rather high temperatures (room temperature). Tallowiness is more prevalent in print butter than in tub butter and both the development of the tallowy flavor and the bleaching, start on the surface of the butter and gradually work into its interior. Butter may have turned perfectly white and tallowy on the outside, while its core may still have the normal yellow color and be free from the tallowy flavor.

Characteristics of butterfat from tallowy butter. When solidified the pure fat of tallowy butter has a lard-white color; when melted

it is a clear, almost colorless oil, similar to separator oil, and entirely unlike the golden yellow oil of normal butter. The odor of the fat is strongly tallowy, resembling old tallow.

When distilled with steam, the melted fat from tallowy butter did not relinquish its intense tallowy odor. The odor remained in the residue, it was intensified and more clearly tallowy. This was due, in all probability to the expulsion from the fat, by steam distillation, of butyric or other volatile acids and odors.

The distillate of the steam distillation of the fat from tallowy butter had not the faintest tallowy odor, showing that the tallowy odor cannot be distilled over by steam, but remains in the residue and this residue, being purified of other volatile odors, such as those of the free fatty acids, is very clear, and intense in its tallowiness. The distillate gave a faint reduction with silver oxide. This might be due to the formation of an aldehyde or of formic acid from the breaking down of the lactose in the butter. The reaction product of this formic acid may be the substance which causes the tallowy-odor.

Further evidence of the presence of aldehydes in this tallowy fat is the interesting fact that, although the fat itself is of much lighter color than the fat of the same butter before the butter turned tallowy, the tallowy fat, upon saponification, gave a dark yellow soap, while the fat of the normal butter yielded a soap with a clear straw color. This may be explained to be due to the reaction of an aldehyde with the alkali.

The tallowy butter in a very advanced stage, gradually surrendered its whiteness and turned pink to brown. This brown color is not soluble in the fat, since after filtering, the fat is perfectly clear and entirely free from the brownish color. The water extract from the brown, tallowy melted butter, is also slightly colored and the curd of the same butter is chocolate brown. This indicates that this coloration is very slightly water-soluble and that it is absorbed by the curd. This brown color could not be removed from the curd by washing.

In experiments in which pure butterfat only was used, the samples failed to turn brown with age, the tallowy samples remained white. However, in those experiments in which casein

was incorporated in the pure butterfat, a brownish color always developed with an advanced state of tallowiness. This again suggests that there is an action on the curd in very advanced stages of tallowy butter.

The fat of the tallowy butter appeared to be more crystalline than that of normal butter, and at the same temperature there was a larger precipitation of the high-melting fats. This fact was further borne out by the higher melting point of the tallowy fat as may be noted in table 7.

CONDITIONS WHICH PRODUCE TALLOWY BUTTER

Jensen (1), Duclaux (4) and Browne (5) have independently and conclusively demonstrated that butter and also pure butterfat will turn tallowy by prolonged exposure to atmospheric oxygen and that the development of tallowiness is greatly hastened and intensified in the presence of direct sunlight or at a high temperature (room temperature or above) or both. These investigators show that the chemical changes which occur in the presence of air, light and heat, and which are accompanied by the tallowy taste and odor in butter and in pure butterfat, involve oxidation of the fats, primarily the olein, as indicated by the reduction of the iodine number. Browne further found a marked increase in the acid value which would suggest hydrolysis of the butter fat, producing free fatty acid, and an increase in the Reichert Meissl number, indicating either a breaking-down of the acids of higher molecular weight, or the oxidation of the glycerol, freed by the hydrolysis of the fats, producing formic acid. The probability of the oxidation of the glycerol is substantiated by the fact that, in the case of four samples of so called rancid butter, Browne found a reduction of the amount of the glycerol. Unfortunately, from the standpoint of their consideration here, the results of Browne lack essential information concerning exact temperature and other conditions under which his samples were kept, and it is not clear from his report which of the samples are comparative.

Jensen also recorded a marked decrease in the iodine number and an increase in the acid value in samples of fat from tallowy butter. He attributed the tallowiness to the oxidation of the

olein, on the strength of the decrease of the iodine number, and holds that the increase of the acid value is due to hydrolysis of the fat, as the result of bacterial action in the butter. Duclaux and Mjoen (6) also showed a decrease in the iodine number and of the free fatty acids of butter that had become tallowy upon exposure to air and light.

It appears from the above that it has been the general tendency on the part of these investigators to endeavor to prove that tallowiness is the direct result of oxidation of the oleic acid, as expressed by the iodine absorption number. And, in order to demonstrate the correctness of this assumption, the samples of butterfat used were exposed to most unusual conditions of temperature, light and air. But even under these abnormal conditions, there is room for reasonable doubt that the results obtained bear out the conclusion drawn. It has by no means been conclusively proven, that the oxidized oleic acid, as expressed by the decrease in the iodine number, is the cause of the tallowy odor and flavor, and it is not improbable that the oxidation of the oleic acid is only coincident with tallowiness. While in many cases tallowiness may be accompanied by the oxidation of oleic acid, in other cases, tallowiness may occur without appreciable change in this fat constant. This is strongly suggested by the results obtained by Hunziker, Spitzer and Mills (7), shown in table 1.

Lewkowitsch (8) and Dyer (9) hold that olein is very difficultly oxidized and the former believes that it is the action of the oxygen of the air and of the light on the free fatty acids which causes "rancidity" (rancidity here probably means tallowiness). Duclaux has also shown that the acids present, other than oleic acid, are split off in the proportion in which they are contained in the glycerides. It will be observed in table 8, that butterfat which was intensely tallowy, showed no appreciable change in the acid value. Shaw and Norton (10), as the result of experiments with renovated butter, conclude that the butter oil may be blown at a temperature that will insure its pasteurization, without impairing, in any way, the flavor, grain, or keeping quality of the finished product. This would obviously be impossible, if tallowiness were strictly due to oxidation of the fat.

TABLE 1

Showing average butterfat constants in butterfat from twelve separate churnings. These figures show the averages of the constants in the fresh fat and in the fat after eleven months' storage at room temperature

AGE OF FAT	AVERAGES OF TWELVE SAMPLES OF BUTTERFAT WHEN FRESH AND AFTER ELEVEN MONTHS STORAGE							
	Reichert Meissel number	Iodine number	Insolu- ble acids	Soluble acids	Saponifi- cation value	Melting point	Acid value	Refrac- tive index
			per cent	per cent		°C.		
Fresh.....	29.177	36.093	87.892	6.073	229.316	33.648	1.391	44.155
Eleven months....	29.645	35.971	88.289	6.206	231.673	33.367	2.235	43.608
Difference.....	+0.468	-0.397	+0.397	+0.133	+2.357	-0.281	+0.844	-0.547

All the samples of fat when fresh were perfectly sweet and normal in flavor. After eleven months storage at room temperature they were intensely tallowy. The above figures show that the tallowy flavor was not accompanied by any appreciable decrease in the iodine number.

It should be clearly understood in this discussion of the causes of tallowy butter, that neither the reduction of the iodine number, nor the production of a tallowy odor and flavor under these conditions of exposure to air, light and high temperature, furnish any tangible solution for the prevention of tallowy butter made and handled under commercial conditions. It is a fact well known to the butter manufacturers that air, light and heat produce tallowy butter, and in the manufacture and handling of commercial butter these agents are automatically guarded against. These factors do no longer jeopardize the quality of the butter, with the possible exception of butter made on the farm and of careless handling in retail stores. Over the latter condition the manufacturer seldom has control, but even in the majority of these stores the butter is not subjected to conditions as severe as those which accompanied the bulk of the experiments above described. In fact the great majority of stores handle their butter in iced refrigerators.

The agents which render commercial butter tallowy must, therefore, be other than mere abnormal exposure to air, light and heat. There are oxidizing conditions other than light, air and heat, with which cream and butter come in immediate contact during the process of manufacture and there are other substances

in butter, than the olein of the fat, which may and do yield to oxidation and the products of which might well cause this tallowy odor and flavor.

Experiment with iron and copper. One of the first oxidizing conditions which suggested itself is the presence of metals and their oxides, as oxygen carriers, or by other catalytic action. Two of the most active common metals with which cream and butter come in contact are iron and copper.

In order to determine the power of these metals to make butter tallowy, a sample of fresh, normal butter was divided into three portions. These portions were placed in three petri dishes with covers. To one portion were added two rusty iron nails, in the second portion was imbedded a short piece of copper wire, the third portion was used as a check, no metal being added to it. The three petri dishes containing these portions of butter were covered, and stored at room temperature (65 to 75° F.) in the dark. The samples were prepared March 16 and examined April 20, May 15, and June 15, respectively, with the following results.

TABLE 2

Showing effect of contact with iron and copper on the flavor of butter held at room temperature in closed receptacles in the dark

DATES OF EXAMINATIONS	FLAVOR, ODOR AND COLOR OF BUTTER		
	Check	With iron nails	With copper wire
April 20	Normal {	Immediately around the nails butter was white and had tallowy taste and odor	Immediately around the wire butter had greenish tint with white border. Taste and odor were tallowy
May 15.....	Normal {	Large circle of white. Flavor and odor very tallowy	Green directly around wire. White area increased and went deeper. Flavor and odor very tallowy
June 15.....	Normal {	Entirely white. Flavor and odor very tallowy	Pinkish brown. Flavor and odor very tallowy

The above results show clearly that direct contact of the butter with either iron or copper developed a tallowy flavor and odor

and turned the butter white. In the case of the copper the white color was gradually superceded by a pinkish brown color.

The action started on the surface exposed to the air and gradually went through the entire mass of butter. The action of the copper was apparently much more rapid and more intense than that of the iron.

Experiment with iron hydroxide and copper hydroxide. The above experiment was repeated, but instead of using the metals of iron and copper, the hydroxides of these metals were used. In this trial four drops of a colloidal precipitate of iron hydroxide and of copper hydroxide respectively, was added to samples of 180 grams of butter. The results of this test are shown in table 3.

TABLE 3

Showing effect of hydroxides of iron and copper on flavor, odor and color of butter, made June 7, and kept in the dark

DATES OF EXAMINATIONS.	NUMBER OF SAMPLES	FLAVOR, ODOR AND COLOR OF BUTTER		
		Check	Butter plus iron hydroxide	Butter plus copper hydroxide
Kept at 65° to 75° F.				
June 15.....	a	Normal ¹	Normal	Tallowy and bleached
	b	Normal	Normal	Tallowy and bleached
	c	Normal	Normal	Tallowy and bleached
July 7.....	a	Normal	Normal	Tallowy and bleached
	b	Normal	Normal	Tallowy and bleached
	c	Normal	Normal	Tallowy and bleached
August 9.....	a	Normal	Normal	Tallowy and bleached
	b	Normal	Normal	Tallowy and bleached
	c	Normal	Normal	Tallowy and bleached
Kept at 32° F.				
July 7.....	a	Normal	Normal	Tallowy and bleached
	b	Normal	Normal	Tallowy and bleached
	c	Normal	Normal	Tallowy and bleached
August 9.....	a	Normal	Normal	Tallowy and bleached
	b	Normal	Normal	Tallowy and bleached
	c	Normal	Normal	Tallowy and bleached

¹ The term "normal" refers in all cases and in all tables to the absence of tallowy flavor.

The results in table 3 show similar changes as those in table 2. The butter containing copper hydroxide went tallowy and turned white in one week at room temperature. At 32° F. the action required one month. The iron hydroxide however, failed to produce changes in the butter, the samples so treated remained normal throughout the period of the experiment, again emphasizing the lesser action of the iron and especially in the form of iron hydroxide.

Experiment with hydroxides of iron, copper, nickle and tin, and also the mixed hydroxides derived from brass and german silver, respectively, in the presence of lactose, curd, alkali and acid respectively, in butter and in butterfat. In this experiment, the effect on the flavor, odor and color of butter and butterfat, in the presence of iron, copper, brass, german silver, nickle and tin was determined. Part of the butter was made acid to the extent of 0.4 per cent with lactic acid, to another part enough alkali was added to make the butter contain 0.4 per cent sodium hydroxide. Also to pure butterfat treated with the above metallic hydroxides was added 1 per cent lactose and 0.4 per cent sodium hydroxide, and 1 per cent casein and 0.4 per cent sodium hydroxide, respectively.

In the case of the butterfat with lactose and alkali, the fat was filtered and washed, then to 100 cc. of the melted fat was added 14 cc. water containing 1 per cent lactose and 10 cc. normal sodium hydroxide. The sample was then emulsified by shaking while cooling in water, until congealed.

In the case of the butterfat with casein and alkali, to 100 cc. of the melted fat was added a solution of 1 gram of casein plus 10 cc. of normal sodium hydroxide. The results are shown in table 4.

Table 4 brings out the following interesting facts:

Pure butterfat containing a slight excess alkali and to which lactose had been added, bleached and turned tallowy at room temperature in the dark in two days. After three additional days at room temperature and twenty-three days at 32° F. it was very tallowy and white. These changes occurred both in the presence and absence of metals.

TABLE 4
Showing action of hydroxides of six metals and alloys in acid and alkaline butter and in alkaline butterfat, in the presence and absence of lactose and curd. Samples prepared July 12, 1917, stored at 65° to 75° F. till July 17, and then at 32° F. until August 9

HYDROXIDES OF METALS AND ALLOYS USED	DATES EXAMINED	BUTTER			BUTTERFAT	
		Check	0.4 per cent acid	0.4 per cent NaOH	*0.4 per cent NaOH, 1 per cent lactose	0.4 per cent NaOH, 1 per cent casein
No metal...	July 17	Normal	Sour, slightly bitter, normal	Slightly soapy, normal	Bleached and tallowy white	No characteristic taste
	August 9	Normal	Normal	Normal	Very tallowy, white	Bad flavor, normal
Iron.....	July 17	Normal	Sour, normal	Slightly soapy, normal	Tallowy and bleached	Slightly tallowy
	August 9	Tallowy	Normal	Normal	Very tallowy, white	Normal
Copper.....	July 17	Slightly bleached	Normal	Slightly fishy	Tallowy and bleached	Slightly tallowy and bleached
	August 9	Very tallowy, slightly bleached	Slightly tallowy, slightly bleached	Tallowy, bleached	Very tallowy, white	Tallowy, bleached
Brass.....	July 17	Slightly bleached	Normal	Normal	Tallowy and bleached	Slightly tallowy and bleached
	August 9	Very tallowy, slightly bleached	Slightly tallowy, slightly bleached	Tallowy, bleached	Very tallowy, white	Tallowy and bleached

TABLE 4—Continued
Showing action of hydroxides of six metals and alloys in acid and alkaline butter and in alkaline butterfat, in the presence and absence of lactose and curd. Samples prepared July 12, 1917, stored at 65° to 75° F. till July 18, and then at 32° F. until August 9

HYDROXIDES OF METALS AND ALLOYS USED	DATES EXAMINED	BUTTER				BUTTERFAT	
		Check	0.4 per cent acid	0.4 per cent NaOH	0.4 per cent NaOH 1 per cent lactose	0.4 per cent NaOH 1 per cent casein	
German silver.....	July 17	Slightly bleached	Normal	Normal	Tallowy and bleached	Slightly tallowy and bleached	
	August 9	Very tallowy and bleached	Slightly tallowy, slightly bleached	Tallowy, bleached	Very tallowy, white	Tallowy, bleached	
Nickel.....	July 17	Normal	Normal	Slightly metallic	Tallowy and bleached	Normal	
	August 9	Normal, slightly bleached	Normal	Normal, slightly bleached	Very tallowy, white	Very slightly tallowy	
Tin.....	July 17	Normal	Normal	Normal	Tallowy and bleached	Normal	
	August 9	Normal, slightly bleached	Normal	Normal	Very tallowy, white	Very slightly tallowy	

* Was bleached and tallowy July 14.

Pure butterfat emulsified with casein and slight excess of alkali showed slight tallowiness and bleaching after five days at room temperature, only in the presence of iron, copper, brass and german silver, respectively. The fat with casein in alkaline solution, without metals, and that with nickle and with tin, respectively was normal. After twenty-three additional days at 32°F. the fat with the copper, brass, and german silver became intensely tallowy and bleached, while with nickle and with tin, it turned slightly tallowy only and without perceptible bleaching.

The butter with a normal content of lactose and without addition of acid, alkalies, or metals remained normal for the entire period of the experiment.

The same butter made acid or alkaline, but without the addition of metals remained normal.

The butter with iron in the absence of added acid or alkali, was tallowy in twenty-eight days, the same butter with acid remained normal and with alkali became distinctly fishy.

The butter with copper, brass and german silver, respectively, with or without alkali, turned white and became very tallowy; with high acid, it became slightly tallowy.

The butter with nickle or tin did not turn tallowy and did not bleach, neither with acid nor with alkali.

The above results, then show that lactose in the presence of an alkali is capable of turning butter and butterfat extremely tallowy and perfectly white. Copper, brass and german silver, in the form of precipitated hydroxides also cause very rapid and intense bleaching and tallowiness in the presence of an alkali in butter. The same metallic hydroxides are capable of producing tallowiness and bleaching in the absence of an alkali, though the action is somewhat slower. In butter with excess acid, these metals also produce tallowiness and bleaching, but to a lesser degree. The action of iron in butter, with excess acid or excess alkali is slight and that of tin and nickle is negligible. The presence of casein appears to have no effect with reference to tallowiness.

It is realized that in the case of the samples to which alkali was added the treatment was probably in excess of slight over-

neutralization. It should be remembered, however, that both, the fat and the butter, have a slight acid value so that the actual alkalinity was slight. It may be further noted that this amount of alkalinity is not necessary to produce tallowiness, by referring to experiment table 5, in which the samples with a very nearly neutral reaction and containing lactose turned equally tallowy and to table 8, in which the butterfat actually acid, and containing lactose, turned tallowy.

Experiment with iron and copper, lactose and curd in the presence of alkali and acid in butterfat. In order to secure additional data showing the influence of acidity and alkalinity in the presence of lactose, curd and metals, the foregoing experiment was repeated. The metals used in this test were confined to iron and copper in the form of lactates.

The butterfat was secured from freshly churned unsalted butter, by melting and filtration in the incubator at 45°C. The filtering occupied twenty-nine hours. The fat was washed twice with hot distilled water.

The samples with acid, alkali, lactose and curd, respectively, were prepared by adding the calculated amount of these chemicals in sufficient dilution, so as to make each sample of fat contain from 14 to 15 per cent water.

The iron and copper were added in the form of iron lactate and copper lactate, using three drops of a solution of the metallic lactate to 60 grams of the prepared sample. Exception was made in sample 7 in which case 6 drops of the metallic salt was added.

The curd used was prepared by centrifuging buttermilk, washing the precipitate with distilled water and centrifuging again.

The amount of chemicals used and the amount contained in the finished samples was as follows:

180 grams of prepared samples contained respectively:

10 cc. lactic acid solution, or 0.54 gram or 0.3 per cent lactic acid

6 cc. lactose solution, or 0.63 gram or 0.35 per cent lactose

13 grams curd suspension, or 0.9 gram or 0.5 per cent curd

2 cc. N/2 sodium hydroxide, equivalent to 0.022 per cent NaOH

After the solutions containing the several ingredients had been added to the pure, melted fat, the mixture was cooled by shaking in cold water, until congealed. Three samples (a, b and c) were prepared, of each lot.

The results are assembled in table 5.

The results shown in table 5, correspond with those of the previous experiment. Again the action of the iron was relatively slight, somewhat more pronounced in alkaline reaction than in the presence of acid. The copper again produced intensely tallowy flavor and bleached the fat. This action was strongest in the fat with slight alkaline reaction. The casein failed to produce tallowiness, but yielded a yeasty odor in the presence of acid and a cheesy and putrid odor in the presence of an alkali. The lactose in normal and in acid fat exerted a protective action. Especially was this true in the case of the samples with lactose and acid, which remained perfectly normal, even those containing iron and copper, respectively. In the fat with slight alkaline reaction the lactose intensified the tallowiness. The acid again retarded the development of tallowy flavor while the alkali enhanced it.

The samples also showed marked variations in the consistency of the fat. The fat that was tallowy was extremely granular, that which remained normal and contained no casein was moderately granular and that which contained casein was smooth and soft.

After forty days additional storage at 70° F. these samples were again examined with the following findings:

The samples which had shown tallowiness, or traces of tallowiness, at the time of the first examination, for the most part had developed more intense tallowiness and in many cases were bleached more. The samples with lactose in acid solution (sample 2) remained normal. In samples 3 and 4, containing casein, the slight tallowy flavor was no longer noticeable, prob-

TABLE 5

Showing effect of iron, copper, acid, alkali, lactose and casein respectively on flavor and color, of butterfat, after eight days' storage at a temperature of 70° F.

SAMPLE NUMBERS	SAMPLES CONTAINING ACID, ALKALI, LACTOSE AND CASEIN	FLAVOR AND COLOR OF BUTTERFAT			
		Samples containing no metals	Samples containing iron or copper		
			Iron	Copper	
No. 1	{ a } { b } { c }	} 0.3 per cent acid	Normal	Very slightly tallowy	Very slightly tallowy
			Normal	Very slightly tallowy	Very slightly tallowy
			Normal	Very slightly tallowy	Very slightly tallowy
No. 2	{ a } { b } { c }	} 0.3 per cent acid } 0.35 per cent lactose	Normal	Normal	Normal
			Normal	Normal	Normal
			Normal	Normal	Normal
No. 3	{ a } { b } { c }	} 0.3 per cent acid } 0.5 per cent casein	Yeasty odor	Very slightly tallowy, yeasty	Slightly yeasty odor
			Yeasty odor	Very slightly tallowy, yeasty	Slightly yeasty odor
			Yeasty odor	Very slightly tallowy, yeasty	Slightly yeasty odor
No. 4	{ a } { b } { c }	} 0.3 per cent acid } 0.35 per cent lactose } 0.5 per cent casein	Yeasty odor	Very slightly tallowy, yeasty	Yeasty odor
			Yeasty odor	Very slightly tallowy, yeasty	Yeasty odor
			Yeasty odor	Very slightly tallowy, yeasty	Yeasty odor
No. 5	{ a } { b } { c }	} 0.35 per cent lactose	Normal	Normal	Slightly tallowy and bleached
			Normal	Normal	Slightly tallowy and bleached
			Normal	Normal	Slightly tallowy and bleached
No. 6	{ a } { b } { c }	} 0.5 per cent casein	Cheesy and putrid	Cheesy and putrid	Cheesy and putrid
			Cheesy and putrid	Cheesy and putrid	Cheesy and putrid
			Cheesy and putrid	Cheesy and putrid	Cheesy and putrid

No. 7	{ a } b c	{ 0.022 per cent NaOH	Normal flavor, bleached	Slightly tallowy, slightly bleached	Very tallowy, bleached
			Normal flavor, bleached	Slightly tallowy, slightly bleached	Very tallowy, bleached
			Normal flavor, bleached	Slightly tallowy, slightly bleached	Very tallowy, bleached
No. 8	{ a } b c	{ 0.022 per cent NaOH 0.35 per cent lactose	Normal flavor	Slightly tallowy, slightly bleached	Very tallowy, white
			Normal flavor	Slightly tallowy, slightly bleached	Very tallowy, white
			Normal flavor	Slightly tallowy, slightly bleached	Very tallowy, white
No. 9	{ a } b c	{ 0.022 per cent NaOH 0.5 per cent casein	Putrid, slightly bleached	Putrid, slightly bleached	Tallowy, white
			Putrid, slightly bleached	Putrid, slightly bleached	Tallowy, white
			Putrid, slightly bleached	Putrid, slightly bleached	Tallowy, white
No. 10	{ a } b c	{ 0.022 per cent NaOH 0.35 per cent lactose 0.5 per cent casein	Stale, slightly bleached	Stale, slightly bleached	Stale, slightly bleached
			Stale, slightly bleached	Stale, slightly bleached	Stale, slightly bleached
			Stale, slightly bleached	Stale, slightly bleached	Stale, slightly bleached
No. 11	{ a } b c	{ Check	Normal	Normal	Tallowy, slightly bleached
			Normal	Normal	Tallowy, slightly bleached
			Normal	Normal	Tallowy, slightly bleached

ably due to the intense putrid and moldy odor which developed in them and which covered up the original slight tallowy odor. In the case of sample 5, containing lactose, all samples had become intensely tallowy and the samples containing copper in addition to lactose were also white as well as tallowy. In samples of no. 6, containing casein, the cheesy and putrid odors were intensified and also tended toward a sharp moldy odor. Samples 7 and 8 which consisted of butterfat in neutral or very slightly alkaline condition, and butterfat plus lactose in neutral or very slightly alkaline condition, all turned very tallowy and were practically white. Samples 9 and 10 containing casein, became more intensely putrid, except the samples containing copper, especially those of sample 10, which became intensely tallowy and bleached. Samples of no. 11 representing the check, remained normal without metals. Those with iron turned slightly tallowy and those with copper very tallowy and white. All samples which contained casein and which had turned tallowy became brown on the surface, while those containing no casein, and which, in many cases were much more tallowy, turned white on the surface.

Experiment in which the wrapper was treated with chemicals. Previous experiments showed that the bleaching and the development of tallowy flavor and odor commenced on the surface and continued into the body of the butter. They also showed that lactose in alkaline solution greatly accelerated the action. Since parchment paper contains glucose, which has reducing powers, similar to lactose, and since the process of parchenting may leave an excess of alkali (ammonia) on the wrapper, it was deemed advisable to repeat the previous experiment, but instead of treating the butter with the reagents, under consideration, normal butter was used and the wrapper was treated. The wrappers were treated as follows:

The wrappers were dipped in solutions of the salts of iron and copper. One sheet of each was then dried and these represented the wrappers treated with metals only. The other sheets were dipped in a solution of sodium hydroxide, strong enough to precipitate the metals as hydroxides on the paper. Two of each of these parchments were then dried and these represented the wrap-

pers plus metals in the presence of excess alkali. Other wrappers were treated in a similar manner, but instead of using sodium hydroxide, lime water was used. Still other wrappers were subsequently dipped in a solution of lactic acid of sufficient strength to neutralize the alkali, making the sheets acid. One sheet of each of the above preparations was then washed so as to render them only slightly alkaline or acid, respectively. Normal fresh butter was then wrapped in these parchments and stored at 32° F. and 70° F., respectively. The butter was wrapped June 7, and examined June 15, July 7, and August 9. The results are shown in table 6.

Table 6 shows conclusively the following:

The development of tallowy flavor and bleaching starts more rapidly on the surface of the butter than in its interior, suggesting oxidation with help of atmospheric oxygen.

In the presence of an alkali the butter became tallowy and white much more rapidly, than in the presence of an acid. This again suggests oxidation as the cause, because in alkaline condition, it is greatly hastened. This chemical fact is generally accepted and it has been especially demonstrated in the case of reducing sugars such as lactose, and glucose in the presence of an alkali.

Of the two metallic salts copper again proved to be much more active than iron in the production of tallowiness and bleaching. The action of turning tallowy and bleaching was much more intense at room temperature than at 32° F., showing that there is greater danger of the butter becoming tallowy when exposed to unfavorable temperature conditions.

In a subsequent experiment in which the wrappers were treated with non-metallic salts and sugars in both alkaline and acid condition the butter failed to become tallowy. This indicates that the wrapper is not liable to produce tallowiness unless it, or the butter itself contains metallic salts or metals. The water soluble extracts of the wrappers were found to contain glucose and traces of iron with considerable sulphates. Of recent years parchment wrappers have occasionally contained minute specks of metallic lustre. Microchemical analysis of these specks showed them to

TABLE 6
Showing effect of wrapping butter in parchments which had been dipped in iron salts and copper salts and then in solutions of alkalis and acids, respectively, on the flavor and color of butter. The butter was wrapped June 7, 1917

DATE OF EXAMINATION	TEMPERATURE OF STORAGE	CONTROL SAMPLES NOT TREATED	WRAPPERS DIPPED IN THE FOLLOWING REAGENTS							
			Treated with metal only	Sodium hydroxide		Lactic acid		Lime water		
				Strong solution	Weak solution	Strong	Weak	Strong	Weak	
Parchment treated with iron salt										
June 15	70	Normal	Slightly tallowy	Slightly tal-lowy	Normal	Normal	Normal	Tallowy	Normal	
July 7	70	Normal	Slightly tallowy	Tallowy	Tallowy	Normal	Normal	Tallowy	Tallowy	
July 7	32	Normal	Normal	Slightly tal-lowy	Normal	Normal	Normal	Normal	Normal	
August 9	32	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
Parchment treated with copper salt										
June 15	70	Normal	Tallowy	Very tallowy	Very tallowy	Normal	Slightly tallowy	Normal	Slightly tallowy	
July 7	70	Normal	Tallowy	Very tallowy	Very tallowy	Slightly tallowy	Tallowy	Tallowy	Tallowy	
July 7	32	Normal	Tallowy	Very tallowy	Very tallowy	Normal	Normal	Very tal-lowy	Slightly tallowy	
August 9	32	Normal	Tallowy and slightly bleached	Very tallowy	Very tallowy	Normal	Normal	Very tal-lowy	Tallowy	

be or to contain copper. When wrappers containing such specks are used, a green coloration gradually appears on the butter and on parchment where these specks are located. The presence of these copper specks may under favorable conditions, start sufficient oxidation to turn the butter tallowy and to bleach it. They exert a catalytic action which is progressive and may cause the entire package to become tallowy.

FAT CONSTANTS IN TALLOWY BUTTER AND IN THE CONTROL
SAMPLES

The samples of tallowy butter of the previous experiments were mixed and the control samples of the same experiments which did not turn tallowy were mixed. Each of these mixed lots was analyzed for fat constants separately, the results are shown in table 7.

TABLE 7

Showing fat constants in mixed samples of tallowy butter, and in samples of the same butter which did not turn tallowy

FAT FROM TALLOWY BUTTER AND FROM SAME BUTTER NOT TALLOWY	IODINE NUMBER	MELTING POINT	SAPONIFI- CATION VALUE	TRUE ACETYL VALUE	ACIDS AS BUTYRIC	MELTING POINT INSOLUBLE ACIDS
		°C.				°C.
Tallowy.....	38.12	34.6	225.33	8.08	6.72	40.35
Check.....	39.23	32.5	225.30	5.89	6.60	40.04
Difference.....	1.09	2.1	0.03	2.19	0.12	0.30

The above figures show a decrease of 1.09 points in the iodine number of the tallowy fat and an increase in its melting point of 2.1°C. The decrease in the iodine number indicates at least some absorption of oxygen. The increase of the melting point of the total fat of the tallowy butter suggests that acids of higher melting point are formed. Table 7 further shows that there was no appreciable change in the saponification value of the tallowy fat. However, these saponification values undoubtedly have been affected by the alkali present in the mixed tallowy butter, which obviously would saponify a portion of the fatty acid and be washed out. The absence of an increase of the volatile acids, as expressed by the Reichert Meissl Number, indicates that there

was no breaking down of the fatty acids into acids of lower molecular weight. However, the Reichert Meissl number might have been affected in a similar manner as the saponification value in the presence of an alkali.

Since the conclusiveness of the data given in table 7, was somewhat marred by the uncertainty of the amount of alkali present in the fat of the mixed tallowy butter, the determination of the fat constants was repeated and in this case with butterfat to which the same amount of alkali (1 cc. N/2) had been added to each 100 grams of butterfat at the beginning of the experiment. These results are shown in table 8.

TABLE 8
Showing fat constants in fresh and tallowy butterfat

	IODINE NUMBER	SAPONIFICATION VALUE	ACID VALUE	MELTING POINT	FLAVOR
1. Check, pure fat.....	42.855	222.0	0.6	32.9	Fresh
2. 1 cc. N/2 NaOH in sunlight.....	42.20	222.5	0.89	33.5	Tallowy
3. 1 cc. 3 N/OH, 0.5 cc. copper lactose, sunlight.....	41.755	221.6	0.28	34.6	Very tallowy
4. 1 cc. N/2 NaOH, in dark.....	42.405	222.9	0.33	33.5	Turned tallowy while filtering fat for determination
5. 1 cc. N/2 NaOH, 1 per cent lactose, in dark.....	41.91	222.4	0.66	34.3	Very tallowy
6. 1 cc. N/2 NaOH, 1.5 cc. copper lactose, in dark.....	41.79	222.0	0.33	34.5	Very tallowy

In the above experiment pure butterfat was used in lots of 85 grams for each sample. To this fat was added 15 cc. of a solution containing 1 cc. N/2 sodium hydroxide in water, which corresponds to 0.02 of 1 per cent of sodium hydroxide in 100 grams of the mixture. To the solution used in samples 3 and 6, 0.5 cc. of dilute copper lactate solution was added. To the solution used in sample 5, 1 gram of lactose was added. Sample 1 was kept in the dark at 32° F. Samples 2 and 3 were kept exposed to light at 70° F. and samples 4, 5 and 6 were kept in the dark at

70° F. All samples were tightly sealed in glass-stoppered bottles. At the end of thirteen days they were examined for odor and fat constants.

As expected, all samples except the check and sample 4 which contained neither lactose nor copper and was kept in the dark, turned completely tallowy. Sample 4 turned tallowy only while being filtered for determination of fat constants.

The results in table 8 again show a decrease in the iodine number in the case of the tallowy fat. The decrease was greatest (1.1 points) in the fat that was most tallowy. There was also a marked increase in the melting point of the tallowy fat, similar to that shown in table 7. The evidence brought out in these two tables leaves no doubt that there is a slight absorption of oxygen by the fat or fatty acids. However, it does not necessarily follow that it is merely the absorption of oxygen by the oleic acid which causes the development of the tallowy flavor and odor. If oleic acid, which has been exposed to the atmosphere at about 45° C. in a thin layer and which, in this manner has suffered a reduction in the iodine number, from 87 to 79, is added to butter, the butter does not show a tallowy taste or odor. But it was observed that butter containing free oleic acid and which had been exposed to the air, became tallowy very rapidly. This suggests that tallowiness is not the direct result of oxidized oleic acid, but rather that it is caused by products formed in the butter during the absorption of oxygen by the oleic acid, such as glycollic acid ester of oleic acid, the glycollic acid coming from the oxidation of the glycerol. These possible by-products are not formed when the oleic acid is oxidized separately from the butter.

Bearing in mind that the presence of copper, or lactose, the latter only in alkaline solution, produces tallowy flavor very intensely, even in the dark, and at 32° F. and without excessive exposure to air, invites a study of the probable products of these agents. McKenzie (11) states that glycollic acid is one of the chief products of the action of copper hydrate in alkaline solution on lactose. Neff (12) shows that glycollic acid is formed from the sugars with silver oxide. McLeod (13) found that the ac-

tion of copper acetate on glucose, levulose and galactose produced considerable quantities (3 per cent) of glycollic acid. Furthermore, one method of preparation of glycollic acid is that of oxidation of glycerol in a dilute alkaline solution with silver oxide (14).

It is interesting also to note the fact that glycollic acid is naturally found in the fat of sheeps' wool (15) showing the probable close relation between glycollic acid and tallowy odor.

In the presence of these facts it seemed logical to determine the effect of glycollic acid on the flavor and odor of butterfat. The addition to butterfat, of free glycollic acid did not produce tallowy flavor. But the addition of the glycollic acid esters of the fatty acids of butter when warmed with butterfat, produced a tallowy flavor. This was especially the case of the glycollic acid ester made with oleic acid. This flavor was produced strictly in the absence of air, and check samples in which oleic acid alone was added showed no tallowy flavor. Although these results are not borne out by any noticeable increase in the saponification value, it may be readily seen that the glycollic acid ester found, which is necessary to produce tallowiness, may be of such small amount, as to cause no appreciable change in this fat constant. That an exceedingly small amount of glycollic acid ester is sufficient to produce tallowiness is shown by the fact that the addition of 0.25 per cent of this reagent to butterfat, produced a distinctly tallowy odor and flavor. The oleic acid and the oleic acid esters prepared from monochlor acetic acid and silver oleate, which were used had the following constants.

TABLE 9
Showing constants of oleic acid and oleic acid esters used

REAGENTS	IODINE NUMBER	SAPONIFICATION VALUE	ACID VALUE	MELTING POINT	REMARKS
Oleic acid ester of glycollic acid.....	85.13	199.0	189.8	18.6	Calculated ester 5.85 per cent
Oleic acid unexposed.....	86.715	194.6	193.1	16.9	
Oleic acid exposed twenty-four hours	78.82	192.5	188.4	17.7	

RESUMÉ OF CHEMICAL REACTIONS RELATED TO TALLOWY BUTTER

From the foregoing findings we must conclude that the butter defect known as tallowiness is the result of an oxidation process. If this oxidation takes place in the butterfat alone, it is suggested that the compound, which it is necessary to link up with the fatty acids, in order to make butter tallowy, is derived from free glycerol produced by a slight or partial hydrolysis of the fat. This compound appears to be glycollic acid.

It has been conclusively shown that lactose in a neutral or slightly alkaline medium very greatly intensifies the results of oxidation. This is due to the fact that simultaneously with the fat, the lactose is also subject to mild oxidation, producing an excess of glycollic acid, while in the case of pure fat alone, the formation of glycollic acid from the small amount of glycerol alone is much slower. The conditions and agencies favoring oxidation may be conveniently grouped as follows:

1. Exposure of butter or butterfat to air. The oxidation here is intensified in the presence of light or at a high temperature, or both.

2. The presence in butter or butterfat of oxidizing agents such as metals or metallic salts. These act as oxygen carriers or catalyzing agents. From our knowledge of the chemistry of the metals, as well as of the experimental results already obtained, we would expect, that copper salts and alloys of copper, such as brass and german silver, are the most active metals and alloys that enter into the problem in commercial buttermaking. Iron oxide has a specific catalytic action which aids this oxidation process, while in the case of iron bases and salts this action is relatively slight.

3. The presence of an unnatural alkaline condition of the butter or cream from which the butter is made which accelerated any oxidizing action by making the compounds oxidized more susceptible to oxidation. This unnatural alkaline condition may be due to an over neutralization of the cream or other factors which expose butter to alkaline conditions.

APPLICATION OF THESE FINDINGS TO COMMERCIAL CONDITIONS

Air, light and heat. As before stated, these three factors readily bring about oxidation of the fat in butter and butter so exposed is prone to develop a tallowy flavor. This fact is well known to the layman. Tallowiness caused through these channels is comparatively rare, because the commercial butter is guarded against these agents. The wrappers and cartons of print butter, and the liners and paraffined tubs and cubes of bulk butter protect the butter against excessive exposure to air and light. While the butter remains in the creamery, it is usually kept at a temperature far below that at which heat alone is capable of producing tallowiness. Butter intended for immediate consumption (within one to three weeks) does not become tallowy even at ordinary ice box temperature, such as it is exposed to in the store and in the home, unless it contains other agents that cause tallowiness. The bulk of the butter going to the tropics is packed in hermetically sealed cans, which greatly minimizes the action of the heat, owing to the partial exclusion of the air and the entire absence of the light. Butter intended for storage purposes does not develop tallowiness because the temperature of commercial butter storage sufficiently retards the action of air and light. Although under present commercial conditions of manufacture and handling of butter, air, light and heat are improbable causes of tallowiness, their importance should not be ignored and every effort should be made to protect the butter from these agents.

Metals and metallic salts. It has been shown that metals and alloys, such as iron, copper, brass and german silver, and their salts, are capable of turning butter tallowy in a short time. Most of the equipment used in the handling of cream and manufacture of butter is constructed of iron or copper, usually originally coated with tin. When this tin coating wears off, as it always does to a greater or less extent, the iron or copper becomes exposed and often the exposed iron is permitted to rust and the exposed copper allowed to become coated with verdigris. In this condition these metals are the most active, considerable portions

being dissolved by the acid in the cream and thus not only act in the cream, but also find their way into the butter, jeopardizing its quality and inviting the development of tallowy flavor.

This danger can best be minimized, if not entirely avoided, by handling the cream in non-rusty cans and preventing the cans from rusting by systematic and thorough washing, rinsing, steaming and drying; keeping the vats, coils, pasteurizers, forewarmers, pumps, pipes, and conduits well tinned, thoroughly cleaning and drying them after each day's use and flushing them with hot water each morning before circulating the cream; preventing the packing and printing equipment from rusting; and using wrappers and liners only which are free from metals.

Lactose in butter. Sugar in butter, such as lactose, and glucose, under certain conditions, as explained in the succeeding paragraph, give rise to tallowy butter, but when butter is made under proper conditions and containing a normal amount of acid, the presence of lactose has no injurious effect on its flavor and does not constitute in itself, a cause of tallowy butter. In fact, the addition of lactose to butter, when in a normal acid condition, may have a slight preservative effect.

Overneutralization. Overneutralization with any alkali very greatly intensifies the oxidizing action of all the foregoing agents and hastens the development of tallowiness. This can only be permanently prevented by the careful standardization of the entire operation of neutralization, including the testing of cream for acid, the preparation of the neutralizer and the addition of it to the cream. The butter should further be guarded against direct contact with alkalis, by the complete removal from churns, cubes and other packing equipment, of all traces of alkaline wash water and the use of wrapping paper which is free from alkali such as ammonia, which is used to neutralize the sulphuric acid employed in the parchmentizing process.

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THE RELATION OF OIDIUM LACTIS AND PENICILLIUM TO THE KEEPING QUALITIES OF BUTTER

W. B. COMBS AND C. H. ECKLES

Department of Dairy Husbandry, University of Missouri

The factors involved in the deterioration of butter have received considerable study in recent years. Attention has been directed especially towards certain abnormal flavors and attempts made to connect them with the activity of particular microorganisms. Most of the work along these lines, with the exception of the extensive work of Rogers, has been in the nature of a study of the butter itself. The writers are of the opinion that a study of the cream is more likely to yield results, when the action of microorganism is suspected, than is a study of the butter.

The high acidity, the salt content and the limited amount of air make the conditions in butter unfavorable for the growth of the large majority of organisms. The changes that take place in the butter constituents so far as related to microorganisms would presumably be brought about by the activities of enzymes the action of which would not be stopped by these conditions. The cream is a far better media than butter for the growth of organisms and the enzymes produced would necessarily be carried into the butter where the effects might not be apparent until some time after the butter was made. By the time the butter has deteriorated to an appreciable extent, the organisms producing the enzymes may have all disappeared. The little success which has so far been attained in determining the causes of specific defects in butter flavor may be partially at least explained on this basis.

RELATION OF MOLD TO DETERIORATION OF BUTTER

Rather extensive studies have been made of molds and *Oidium lactis* in connection with dairy products especially the ripening of soft cheeses. Several investigators including, Gripenberg (1),

O'Callaghan (2) and Jensen (3) have also concluded that molds and *Oidium lactis* are of importance in relation to the keeping qualities of butter. The study of this problem has, however, been confined to the butter and no attention given to the results of mold growth in cream before churning. The frequent occurrence of mold in butter packages on the market, especially tubs, is responsible for a wide interest in the relation of mold in this form to the keeping quality of butter.

Thom in a recent paper states that molds do not grow readily upon butter. The conditions necessary for its growth are a high humidity of the surrounding atmosphere, a high moisture content, and low salt content of the butter. Experiments by the present authors corroborated these results.

OBJECT OF EXPERIMENTAL WORK

The primary object of the experiments reported in this paper was to determine the relation of *Oidium lactis* and a mold of the *Penicillium* group to the keeping qualities of butter, especially when these organisms had developed in the cream before churning.

Oidium lactis was selected as one of the organisms on account of its wide distribution in dairy products and its well known relation to certain dairy products. A number of molds of the *penicillium* growth the spores of which were found present in butter were studied and a type identified as *P. Chrysogenum* selected for the experiments.

Description of butter. As it is practically impossible to find terms which will convey the idea of the precise flavor of butter it was thought advisable to indicate the flavor of butter examined in these experiments on a percentage basis. Where check samples of butter were compared with the experimental the flavor of the check sample was given a value of 1.00, and variations from the check sample were indicated by decimal parts of 1.00 which shows the extent the butter in question varied from the check according to the judgment of those making the examination.

Butter given a flavor of 1.00 was first class butter while that

ranging between 0.90 and 0.99 would be considered second grade, that graded from 0.75 to 0.89 rather poor, though it could possibly be sold on the market, and that graded 0.70 or below was too inferior for human consumption. The entire series of experiments included 58 separate churnings and observations on 658 samples of butter.

RESULTS OF *OIDIUM LACTIS* AND *P. CHRYSOGENUM* UPON BUTTER

Only a portion of the data taken is given but the results were consistent and conclusive. Pure cultures of the molds grown upon samples of sweet cream were found to be detrimental to the quality of the cream as judged from the standpoint of the practical buttermaker. However, when the same molds were grown upon sour cream no ill effects whatever upon the quality of the cream could be observed. The resulting butter, however, went off flavor very quickly in either case as is shown in table 1.

TABLE 1

The growth of molds upon sweet and sour cream and the effect upon the resulting butter

CONDITION OF CREAM	INOCULATION	QUALITY OF BUTTER			
		Fresh	30 days	60 days	90 days
Sweet.....	Penicillium	1.00	0.90	0.85	0.70
Sour.....	Penicillium	1.00	0.75	0.60	0.50
Sweet.....	Oidium	1.00	0.85	0.75	0.60
Sour.....	Oidium	1.00	0.70	0.65	0.55
Sweet.....	Penicillium and Oidium	1.00	0.70	0.60	0.50
Sour.....	Penicillium and Oidium	1.00	0.80	0.55	0.45
Sweet.....	None (check)	1.00	1.00	0.95	0.75
Sour.....	None (check)	1.00	1.00	1.00	1.00

The above data shows that when the molds made growth upon either sweet or sour cream the resulting butter went off in flavor very rapidly. It is also interesting to note that, though mold growth upon sour cream did not seem to affect the quality of

that cream as judged by taste the resulting butter had poorer keeping qualities than the butter made from the sweet cream on which the molds had previously been grown. The butter made from cream on which the two molds used in the experiments had been allowed to grow together in every case showed a poorer

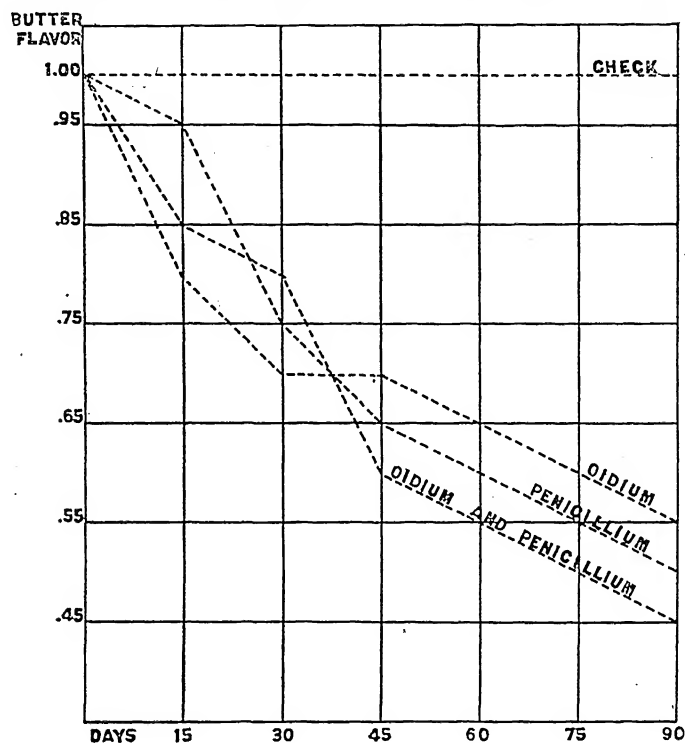


FIG. 1. THE RELATION OF PENICILLIUM AND OIDIUM GROWTH UPON SOUR CREAM TO THE KEEPING QUALITIES OF BUTTER

The growth of these organisms upon cream results in very rapid deterioration of the butter as the figure shows. The check sample, free from mold growth, showed but little deterioration in three months while the butter from the cream in which the molds had grown freely was unfit for human food.

keeping quality than the butter which was made from cream on which only one of the molds had grown. Figure 1 shows graphically the rate of deterioration of the butter made from sour cream in which Penicillium and Oidium had been allowed to grow.

The pronounced effect of mold growth in cream upon the keeping quality of the butter may be explained in two ways: The first is that the mold spores which are produced by the growing molds are carried into the butter and there grow and bring about the decomposition of the butter constituents which results in butter of very poor keeping qualities. The second possible explanation is that the molds while growing upon the cream secrete enzymes which are carried over into the butter at time of making and gradually bring about a decomposition of the butter constituents. Experimental work was conducted to determine which of these is the true explanation. A large number of cream samples were inoculated with the *Oidium lactis* and *P. Chrysogenum* and the butter churned after the molds had developed to the point of forming spores and placed in 100 cc. Erlenmeyer flasks. The flasks were placed at ice box temperature in a receptacle protected from outside contamination and in no case did the mold appear upon the butter, though the cream from which this butter was made must have contained enormous numbers of mold spores. Other trials were made by working large numbers of mold spores directly into freshly made butter but no growth of mold appeared on the surface.

The number of mold spores in a gram was also determined by the plate method for several samples of fresh butter, some of which were stored in a dry and others in a humid atmosphere. In every case there was an actual decrease in the number of mold spores contained in the butter at the end of thirty days. These results seemed to show conclusively that molds are not able to germinate or make growth within butter.

Another series of experiments was conducted to determine if the enzymes produced by the molds while growing upon cream were the cause of the rapid deterioration of the butter made from such cream.

Seven gallon lots of cream were pasteurized and a 5 per cent starter of *B. lactis acidi* added to each. Two were inoculated with *Oidium lactis*, two with *P. Chrysogenum*, two with both organisms, and one was kept for a check. All were allowed to stand at 70° F. for eight days during which an abundant growth was made by

both molds. All were then pasteurized at 145° F. for twenty minutes and cooled to the proper temperature and churned.

Another set of seven was treated in exactly the same manner except the cream samples were pasteurized at a temperature of

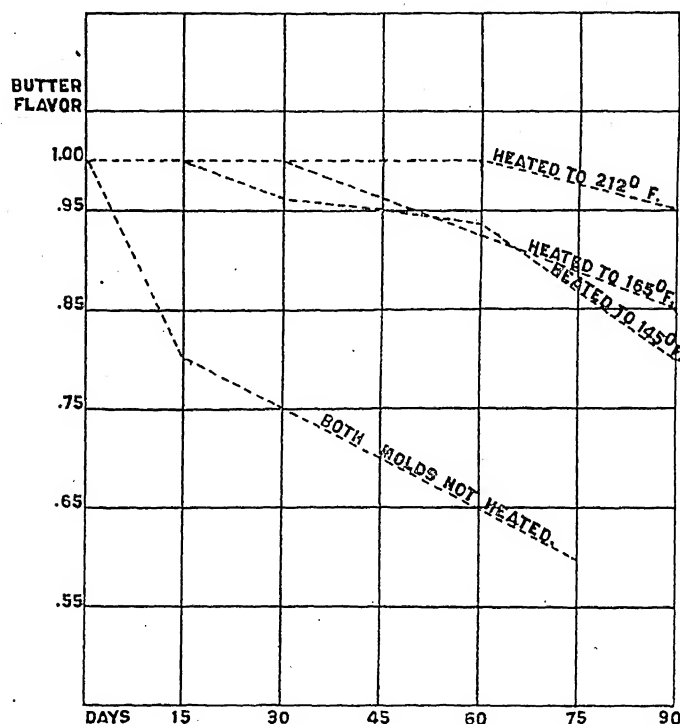


FIG. 2. THE RESULTS OF HEATING CREAM IN WHICH *OIDIUM* AND *PENCILLIUM* HAD GROWN, TO A TEMPERATURE OF 165° F.

These data show that a temperature of 165° F. for five minutes is not sufficient to entirely destroy the action of the enzymes produced in the cream by the molds. In each case the results were the most marked where both organisms had grown together.

165° F. for five minutes. A third set was also a duplicate of the first except the cream was heated to 212° F.

A fourth set of five lots of cream was prepared in a similar manner and four of them inoculated with both molds. One was heated to 145° F., a second to 165° and the third to 212°. One

check contained the mold growth but was not heated and one check was not inoculated.

The results of these experiments showed that heating to 145° F. improved the keeping qualities of the butter over that of the check lot not heated but did not prevent it from going off rapidly

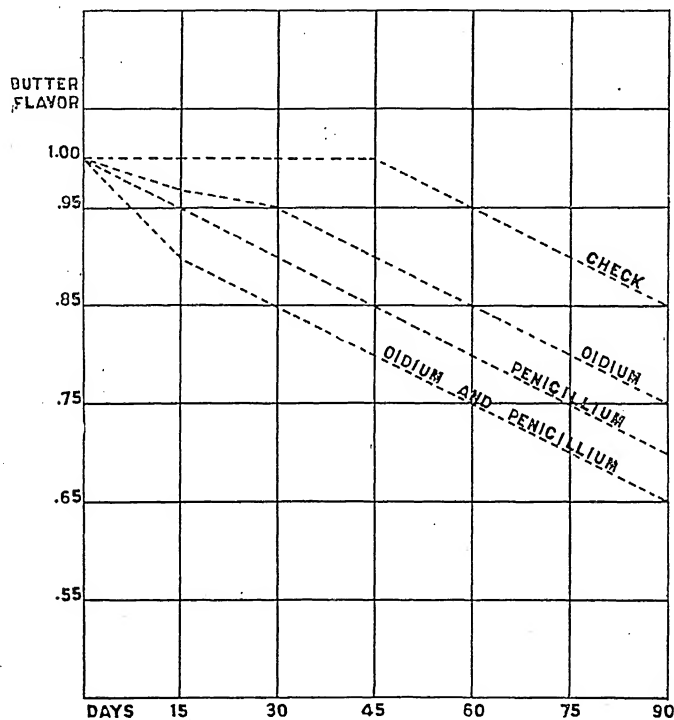


FIG. 3. THE RESULTS OF DIFFERENT TEMPERATURES UPON THE KEEPING QUALITIES OF THE BUTTER

This figure shows the results on the keeping quality of butter of heating cream on which both molds had grown. The keeping quality was greatly improved by pasteurizing at a temperature of 145°F., was still better at 165°, and the least deterioration occurred in that heated to 212°.

in flavor due to the mold growth. Pasteurizing at 165° was more effective than at 145°. At 212° the deterioration due to the presence of the mold seems to be entirely removed. The results of a temperature of 165° F. is shown in figure 2 and a comparison of results at the three temperatures in figure 3.

It will be noted from figure 3 that the butter made from that cream on which the molds were grown and which received no pasteurization went off in flavor very rapidly. By the end of forty-five days the butter from this cream was absolutely unfit for human consumption. These results must be interpreted to mean that the decidedly better keeping quality of the butter from the pasteurized cream was due to the destruction of the enzymes formed in the cream by the molds. It also suggests that the well known beneficial results of pasteurization upon the keeping qualities of butter as practiced in a commercial way is probably to be attributed, to a considerable extent at least, to the destruction of the enzymes produced by various organisms in the cream and milk from which the butter was made.

CONCLUSION

Molds do not grow readily upon butter, but their growth is influenced by the amount of protein, salt and moisture, the butter contains and the moisture of the surrounding atmosphere.

The quality of cream as usually judged by taste is influenced to a marked degree by the growth of *Oidium lactis* and *P. Chrysogenum* when the cream is sweet but no objectionable flavor can be detected in the cream as a result of mold growth when the cream is sour.

The growth of *Oidium lactis* or *Penicillium* upon cream exerts a decidedly detrimental effect upon the keeping qualities of the butter.

Mold spores do not germinate or make growth in butter. The growth of mold on butter is the result of a contamination from the outside.

Pasteurization at ordinary temperatures greatly improves the keeping qualities of butter made from cream upon which molds have made growth but it does not entirely check the action of the enzymes which they produce. This action may be checked entirely by heating to a sufficiently high temperature but this point is beyond the limit of practicability for commercial use.

The abnormal flavors which develop in butter, due to mold

growth on the cream, are caused by enzymes which are secreted by the mold in the cream.

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RULES AND REGULATIONS FOR CLEAN AND SAFE MILK SUPPLY¹

ERNEST KELLY, JOHN B. NEWMAN AND GEORGE S. HINE

Your committee realizes that the task set before it is one of the most important, as well as one of the most difficult, that could have been selected. It is important because upon it depends the protection of the consumer against impure milk, the safeguarding of the dairyman against unreasonable requirements, and the unifying of inspection systems; and it is difficult, because out of a diverse and multitudinous mass of regulations must be selected the clear, simple directions which will make possible the accomplishment of the desired results.

Much of the dissatisfaction with milk inspection in the past has been due to the fact that local authorities have had enacted into law their personal opinions which were often based on insufficient experience. Such a course was natural; bad conditions had to be dealt with; action was necessary; and officials moved along lines that seemed best to them. Many health officials have not the facilities for carrying on research work and must depend to a great extent upon the findings of others. Slowly but surely investigating bodies have been at work on the problem of dairy sanitation and we now understand more fully some of the basic principles.

Your committee feels some trepidation in dealing with this subject, because we realize that many men have many minds; and it is almost impossible to draw conclusions which will satisfy everyone and which will not be liable to misinterpretation. In outlining the following regulations, we do so realizing that we have not perhaps incorporated in them all that should be incorporated; but we do believe that they constitute the fundamental principles of clean and safe milk. We further believe that if these rules are carried out our cities will have all reasonable as-

¹ A report of the International Dairy and Milk Inspectors' Committee on Rules and Regulations Necessary for Securing a Clean and Safe Milk Supply.

surance of a pure milk supply. We have not attempted to deal with chemical standards or other considerations more or less of a local problem.

RULES FOR PRODUCTION

1. Every dairy producing market milk should be licensed by the city or State so that a complete record may be kept.

2. Cattle should be healthy as determined by the tuberculin test and a physical examination by a competent veterinarian. They should be tested at least once a year and where reactors are found they should be removed and a retest conducted within six months. If the milk is to be properly pasteurized, the physical examination may suffice, but the committee wishes to affirm its belief in the economic and sanitary importance of the tuberculin test. Milk should be unsalable from cows within fifteen days before calving and as long thereafter as the milk is abnormal. (7 enough)

3. All persons engaged in the production of milk should be free from communicable disease and from contact with any such disease. Medical examination of employees is advised where feasible.

4. Every operator of a dairy farm should, within twenty-four hours, notify the health department having jurisdiction over his milk, of the presence of any communicable disease on his farm or among the milk handlers.

5. The water supply on premises where milk is produced should be abundant and protected from contamination. It should be free from any disease-producing organisms.

6. Privies on dairy farms should be fly-proof, and provided with a water-tight receptacle for the excreta. The excreta should be removed frequently and buried at least two feet deep, where it cannot contaminate the water supply.

7. Cows should be clean. They should be free from accumulations of dirt and their udders and flanks should be wiped with a clean, damp cloth just previous to milking.

8. Milking should be done with clean, dry hands or with a properly sterilized mechanical milker. Milkers should milk in clean clothing.

9. Some type of small-top milking pail should be used.

10. Milk should be removed as soon as drawn, to a clean place, strained through a new cotton or other clean, efficient strainer, and be cooled within one hour to 50° F. or less. It should be kept covered and be held below 50° F. at all times.

11. All utensils which come in contact with milk should be thoroughly washed and sterilized for at least five minutes with steam or boiling water. They should be kept inverted and protected from contamination until used.

RULES FOR TRANSPORTATION

During transportation from farm to city, milk should be kept free from contamination and should be held at or below 50° F.

RULES FOR HANDLING AND DELIVERY

1. All persons engaged in the sale of milk should be licensed by the State or city in which they conduct their business.

2. All persons engaged in the handling or delivery of milk should be free from communicable diseases and from contact with such diseases. The operator of any milk plant should immediately advise the health department of the presence of any such diseases among his employees or in their homes.

3. The water supply of all establishments where milk is handled should be pure and free from disease-producing organisms.

4. Proper toilet facilities should be provided for all employees, together with wash bowl, soap and towel for the cleansing of hands.

5. Where pasteurization is performed, a temperature of approximately 145, and never less than 142° F. should be maintained for at least thirty minutes.

6. All machinery, cans, bottles, etc., with which milk comes in contact should be thoroughly washed and sterilized with steam or boiling water; and they should be protected from contamination until used.

7. At all times, except during pasteurization, milk should be held at or below 50° F. until delivered to the consumer.

8. Milk should be delivered to the consumer only in bottles or sealed cans.

RECOMMENDATIONS

Production

Your committee wishes to emphatically state that many things are desirable in the production and handling of milk that may not greatly affect the bacteria count. Common decency, economy and the esthetic effect on the buyer demand close attention on the part of the dairyman to many details regarding which it may not be advisable to legislate. Such things as clean stables, whitewashing, bedding, etc., come in this category. The comfort and health of the herd depend to a certain extent on clean, light, airy quarters and abundant, wholesome food and water.

In view of these facts your committee considers that a system is advisable, which combines sanitary inspections and laboratory examinations. Practical experience has shown that the dairy score card offers the most useful medium for sanitary inspection, because it serves as a guide to both inspector and inspected. We therefore urge the continued use of a uniform standard score card based on the fundamentals of dairy sanitation.

TRANSPORTATION

It is recommended that covered platforms be maintained for the protection of milk awaiting shipment. Milk should be shipped in refrigerator cars, or in special or jacketed cans which will maintain low temperatures. Cans of milk should be sealed at the farm to prevent tampering en route.

Handling and delivery

Considerations regarding general cleanliness apply in the city as well as at the farm.

Your committee is of the opinion that the proper pasteurization of milk provides an additional safeguard without any ap-

preciable disadvantages and is necessary with all milk except certain special classes; and it is probably advisable with those. Automatic temperature controls and recording devices are recommended.

We recommend that no dipped milk be sold either from stores or wagons. We further recommend that milk bottles be capped by machine and that the mouths of the bottles be protected by a covering.

Repasteurization of milk is undesirable.

Conclusion

Your committee wishes to state that it has had no intention to cover the whole broad field of milk control, but simply to define the necessary regulations from a sanitary standpoint. Following such rules will eliminate many needless burdens on the dairymen. At the same time those things which have a definite effect on milk quality must be maintained even though they may result in additional costs which must be passed on to the consumer as his share in a national health insurance.

THE STANDARDIZATION OF MARKET MILK

L. L. VAN SLYKE

New York Agricultural Experiment Station, Geneva, New York

The standardization of market milk is attracting much attention at the present time. Very little information is available in regard to it. This article has for its purpose a discussion of this subject with a view to furnishing some desirable facts. The treatment is intended to be suggestive rather than exhaustive.

What do we mean by the standardization of milk? Or, perhaps, it is better to put the question in this form: "What do we mean by standardized milk?" We get no help from the dictionary. What kind of a standard have we in mind? Is it a sanitary standard, covering the number of bacteria in milk, the amount of dirt, acidity, etc.? Or is it a standard of composition based on fat and solids? Or is it something else?

It becomes obvious at once that the expression "standardized milk" does not carry its meaning on its face. As a matter of fact there is no generally recognized, authentic definition. Our chief interest in this connection is some sort of a reasonable statement which applies to conditions in New York State and which can be utilized as a basis for our discussion.

Another expression is in common use, synonymous with standardized milk, and that is "adjusted milk." It is therefore desirable to incorporate these two terms in our definition.

The following statement is offered as a definition of the kind of milk that forms the subject of our discussion:

Standardized milk or adjusted milk is milk in which the original fat content has been changed, and also the ratio of fat to the other milk solids, by the removal of milk-fat, or by the addition of skim-milk, or by the addition of cream.

Of course, when it comes to legalizing the sale of standardized or adjusted milk, then we have to consider the application of

this definition under conditions of specific limitations and regulations, as will be pointed out later in some detail.

We will now consider the subject in the following relations:

1. Effect of standardizing or adjusting milk upon the composition of normal milk.
2. Relations of standardized or adjusted milk to producers, distributors and consumers.
3. Advantages and objections.
4. Legal regulations relating to the production and sale of standardized or adjusted milk.

1. EFFECT OF STANDARDIZING MILK UPON ITS COMPOSITION

The fat content of milk can be changed, with a change of ratio of fat to other solids, either by decreasing or increasing the percentage of milk-fat. In either case we have a standardized or adjusted product.

We will first consider the case in which we have a reduction of milk-fat. The percentage of fat in milk can be decreased, with change of ratio of fat to other solids, either by removal of fat or by addition of skim-milk. This is ordinarily accomplished in practice by separating a portion of the milk and then adding the skim-milk thus obtained to the remaining whole milk. Just how the reduction of the percentage of fat is accomplished is, however, immaterial for our present purpose. What we want to know now is the effect of such reduction upon the composition of normal milk.

When we remove cream from milk, the chief solid constituent that we take out is milk-fat. It is true that we also take out small amounts of other solids, which we commonly speak of as solids-not-fat, these including sugar, casein, albumin and salts of milk. But, for all practical purposes, in studying the effect of removal of fat on composition of milk, we are justified in saying that only fat is removed. Therefore, when we take cream from milk we reduce the percentage of fat in the milk but not appreciably the percentage of the other solids, the solids-not-fat.

We can readily make these statements clear by a few illustra-

tions. The figures which we give are sufficiently accurate for our purpose and for all practical purposes.

We will start with normal milk containing 4 per cent of milk-fat and 9.1 per cent of solids-not-fat. When we take 100 pounds of such milk and remove 1 per cent of fat, that is, 1 pound of fat, it is obvious that we have 3 pounds, or about 3 per cent of fat left in the milk. How about the solids-not-fat? We have essentially the same amount as in the normal milk before removal of fat, that is, about 9.1 per cent. We can bring out somewhat more clearly what happens by comparing this standardized or adjusted milk, made to contain 3 per cent of fat, with the composition of normal milk, containing 3 and 4 per cent of fat.

	FAT	SOLIDS-NOT-FAT	RATIO OF FAT TO SOLIDS- NOT-FAT
	<i>per cent</i>	<i>per cent</i>	
Normal milk containing.....	3	8.60	1:2.87
Normal milk containing.....	4	9.10	1:2.27
Adjusted milk containing.....	3	9.10	1:3.03

These figures show clearly that in milk standardized or adjusted to contain 3 per cent of fat, made from normal milk containing 4 per cent of fat, we have the same amount of fat as in normal milk containing 3 per cent of fat, but we have the 9.1 per cent of solids-not-fat contained in normal milk carrying 4 per cent of fat. Normal milk containing 3 per cent of fat contains an average of about 8.60 per cent of solids-not-fat, while standardized or adjusted milk containing 3 per cent of fat and made from normal milk containing 4 per cent of fat, contains 9.1 per cent of solids-not-fat. In other words, such a standardized or adjusted 3 per cent fat milk contains per 100 pounds one-half pound more of solids-not-fat than does normal 3 per cent fat milk.

In the last column of the table above, we have the amount of solids-not-fat for each pound of fat in milk in the different milks. It is obvious that the removal of fat changes very noticeably the ratio or proportion of fat to solids-not-fat, raising it from 2.27 in normal 4 per cent fat milk to 3.03 in the adjusted or standardized 3 per cent fat milk.

Similar results, only more striking, are shown when normal milk containing 5 per cent of fat is adjusted or standardized to contain 3 per cent of fat. We have the results shown by the following figures:

	FAT	SOLIDS-NOT-FAT	RATIO OF FAT TO SOLIDS- NOT-FAT
	<i>per cent</i>	<i>per cent</i>	
Normal milk containing.....	3	8.60	1:2.27
Normal milk containing.....	5	9.50	1:1.90
Standardized milk containing.....	3	9.50	1:3.17

In this case the standardized or adjusted 3 per cent fat milk, made from normal 5 per cent fat milk, contains the solids-not-fat belonging to normal 5 per cent fat milk, that is, about 0.9 pound more per 100 pounds than in normal 3 per cent fat milk. The ratio of fat to solids-not-fat in the adjusted milk is 1:3.17, which is much higher than in normal 3 per cent fat milk.

We will give one more illustration, showing the results of adjusting normal 5 per cent fat milk to standardized milk containing 4 per cent of fat.

	FAT	SOLIDS-NOT-FAT	RATIO OF FAT TO SOLIDS- NOT-FAT
	<i>per cent</i>	<i>per cent</i>	
Normal milk containing.....	4	9.10	1:2.27
Normal milk containing.....	5	9.50	1:1.90
Adjusted milk containing.....	4	9.50	1:2.47

In this case the adjusted milk contains 4 per cent of fat but it contains the amount of solids-not-fat belonging to normal milk containing 5 per cent of fat.

The figures furnished by the three preceding illustrations all go to show that *when the percentage of fat in milk is reduced, the resulting standardized or adjusted milk contains the percentage of solids-not-fat in the original normal milk.* Therefore, the food value of the adjusted milk is somewhat greater than in case of the normal milk containing the same percentage of fat as that to which the richer milk has been reduced. Standardized or

adjusted milk containing 3 per cent of fat and made from richer milk is richer in solids-not-fat than normal milk containing 3 per cent of fat. Standardized or adjusted milk containing 4 per cent of fat and made from richer milk is richer in solids-not-fat than is normal milk containing 4 per cent of fat.

Next, let us see what happens to the composition of milk when it is standardized or adjusted by the reverse process, that is, by the addition, instead of removal, of cream. Briefly answered, such standardized milk contains obviously more fat than the original milk, but it contains essentially the same percentage of solids-not-fat as the original milk. Such adjusted or standardized milk contains a smaller percentage of solids-not-fat than does normal milk containing the same percentage of fat.

We will illustrate these statements first by seeing what happens when we add enough cream to normal 3 per cent fat milk to make it into an adjusted milk containing 4 per cent of fat.

	FAT	SOLIDS-NOT-FAT	RATIO OF FAT TO SOLIDS- NOT-FAT
	<i>per cent</i>	<i>per cent</i>	
Normal milk containing.....	3	8.60	1:2.87
Normal milk containing.....	4	9.10	1:2.27
Adjusted milk containing.....	4	8.60	1:2.15

Here, in the case of the normal 3 per cent fat milk, made into standardized 4 per cent fat milk, we see that, while the fat increases to 4 per cent, the solids-not-fat remain at 8.60 per cent just as in the normal 3 per cent fat milk. The adjusted milk contains the fat of 4 per cent milk but the solids-not-fat of normal 3 per cent fat milk. Such standardized milk has less food value by $\frac{1}{2}$ pound of solids-not-fat per 100 pounds of milk than is contained in normal milk containing 4 per cent of fat. The ratio of fat to solids-not-fat is reduced from 2.27 to 2.15 for 4 per cent fat milk, normal and standardized.

Let us take one more illustration, adjusting normal 3 per cent fat milk to standardized milk containing 5 per cent of fat.

	FAT	SOLIDS-NOT-FAT	RATIO OF FAT TO SOLIDS- NOT-FAT
	<i>per cent</i>	<i>per cent</i>	
Normal milk containing.....	3	8.60	1:2.87
Normal milk containing.....	5	9.50	1:1.90
Standardized milk containing.....	5	8.60	1:1.72

We have here in more exaggerated form results similar to those obtained in the preceding illustration. The adjusted milk contains 5 per cent of fat, but only 8.60 per cent of solids-not-fat instead of 9.50 per cent of solids-not-fat, which is the amount that normally goes with milk containing 5 per cent of fat. The ratio of fat to solids-not-fat drops from 1.90 in the normal milk to 1.72 in the standardized milk.

Summarizing the results which have been presented in showing the effect of standardizing or adjusting milk upon the composition, we have seen:

1. When we decrease the percentage of fat in normal milk by removal of cream or by addition of skim-milk, we readjust not only the percentage of fat but particularly the ratio or proportion of fat to the other milk solids. This readjustment has the effect, it may be said, of standardizing or adjusting the solids-not-fat *up* in relation to fat.

2. When we increase the percentage of fat in normal milk by the addition of cream, we readjust the ratio or proportion of fat to solids-not-fat in such a way that we standardize or adjust the solids-not-fat *down* in relation to fat.

3. When we standardize or adjust milk by reducing the percentage of fat, we increase somewhat the food value of the milk in solids-not-fat in comparison with normal milk containing the same percentage of fat as the standardized or adjusted milk. Thus, for example, standardized 3 per cent fat milk, made from 4 per cent fat milk, has somewhat more food value in solids-not-fat than has normal 3 per cent fat milk.

4. When we adjust or standardize milk by addition of cream, we decrease somewhat the food value of the milk in solids-not-fat in comparison with normal milk containing the same percentage

of fat as the adjusted or standardized milk. Thus, for example, standardized or adjusted 4 per cent fat milk, made by adding cream to 3 per cent fat milk, has somewhat less food value in solids-not-fat than has normal 4 per cent fat milk.

2. RELATIONS OF STANDARDIZATION OF MILK TO PRODUCERS, DISTRIBUTORS AND CONSUMERS

Producers who sell milk to distributors may have little or no interest in the standardization of milk. However, it is probable that some questions now unforeseen might develop, affecting the interests of such producers. Those producers who sell milk directly to consumers might find it to their advantage to standardize their milk, especially when their herds may produce milk below the minimum legal standard. It would also be of advantage when milk of fairly uniform fat content is desired by one's customers. It is probable, however, that standardization would be made use of by producers only in exceptional instances.

The desire to introduce the practice of standardizing or adjusting milk comes mainly from distributors who handle large amounts of milk gathered from an extended territory for the purpose of supplying cities. The milk which they purchase from individual producers varies more or less widely in composition, especially in percentage of fat. Under present methods of mixing milk in a haphazard way, the milk distributed to consumers varies more or less in composition. If standardization is permitted, a product of much greater uniformity in percentage of fat can be furnished. Further, in case at any time a large amount of normal milk should drop below the minimum legal standard of 3 per cent of fat, the milk before distribution can easily be brought above such standard by adjusting. Again, dealers who desire to furnish regularly to customers milk above a definite guaranteed percentage of fat can do so more conveniently by means of standardization than is possible under present conditions.

In relation to consumers, standardization of milk is a matter of practical interest. It would be practicable for them to obtain milk

of a more uniform composition and also of any definite composition in milk-fat whether 3, 4, 5 or other percentage were desired.

These statements indicate some of the more obvious and important relations that standardization of milk bears to the three parties interested.

3. ADVANTAGES AND OBJECTIONS IN RELATION TO STANDARDIZATION OF MILK

The more obvious advantages that would result from the standardization of market milk have just been stated under the preceding heading. Are there any disadvantages or objections? There may be.

1. Without some kind of legal control, the result of standardizing or adjusting market milk would be the inevitable tendency to lower the composition of such milk to a point not much above the minimum legal standard, at present 3 per cent of fat and 11.50 per cent of milk solids in New York State. Market milk would not only tend to become fairly uniform the year around instead of varying as it now does, but unfortunately the uniformity would be in the direction of a lower percentage of fat than now prevails. The high value of milk-fat in the form of cream would exist as a constant temptation to standardize nearly all normal milk above 3.50 per cent of fat to a lower fat content.

2. Milk cannot be standardized or adjusted without extra handling and this results in exposure to possible bacterial contamination. Without special care in manipulating milk when going through the process of standardization, the sanitary character may easily be unfavorably affected.

3. In the case of milks enriched by the addition of cream, the consumer gets somewhat less food value in solids-not-fat than he would in buying normal milk having the same percentage of fat. However, this difference is hardly large enough to constitute a serious objection.

4. There is on the part of many consumers a vague feeling of objection to having anything done to market milk that affects its composition; and such persons think that standardizing should not be permitted under any conditions. For many years we have been careful to surround normal market milk with jealous

legal protection and until recently to recognize as legal the sale only of normal milk whatever its composition. Many have thus come unconsciously to regard normal milk, that is the milk produced by the cow, as something the composition of which should not be tampered with in any way, indeed, as something having an almost sacred kind of character. Of course, this is largely a matter of psychology rather than of dairy intelligence. We know that the composition of much normal market milk can be improved in some ways by standardization.

5. Objection is likely to be made to the standardization of milk on the ground that the disturbance of the ratio of fat to solids-not-fat may have objectionable results in connection with the feeding of infants. This objection has little force when we consider the manifold ways in which normal milk is "modified" for infant feeding, producing changes in composition much more extensive than take place when milk is standardized. On the other hand, standardization should result in greater uniformity of composition, a condition especially desired in case of milk for infants.

4. LEGAL CONTROL OF STANDARDIZATION OF MARKET MILK

All who have devoted any thought to the subject of adjusted or standardized milk are agreed (1) that promiscuous, uncontrolled standardization should not be considered under any circumstances; (2) that, if such treatment of milk is permitted it should be controlled by law as completely as practicable; (3) that this must be done in order to prevent the obviously objectionable conditions which would result from lack of such control.

Among the more important conditions that would be necessary to make standardization safe are the following:

(1) No one should be permitted to prepare standardized milk for market purposes without a special state license.

(2) Such conditions of standardizing processes should be prescribed as would insure no impairment of the sanitary quality of the milk.

(3) No standardized or adjusted milk should be permitted to be sold unless it conforms to the present legal minimum requirements in composition (3 per cent of fat and 11.50 per cent of

solids). There are some who suggest that the minimum standard for standardized milk be placed at 3.25 per cent of fat and 12 per cent of solids.

(4) Some believe that all containers of such milk should be marked with the words "standardized" or "adjusted." There may be an honest difference of opinion as to whether this is necessary or desirable. Use of the word "standardized" on containers might easily be misleading to consumers as referring to superior quality, while the word "adjusted" might readily arouse unwarranted suspicion.

(5) Whatever other safeguards it may be judged desirable to place around the standardization of market milk and its sale, the belief cannot be expressed too strongly that *it is all-important to place on every container of standardized or adjusted milk in plain figures the minimum percentage of fat in milk*, which shall stand as a guaranty that the milk in the container contains not less than the specified amount of milk-fat. This would accomplish several important purposes, among which, briefly stated are the following:

1. It would serve as a check to prevent adjusting the fat in all market milk down close to the present legal minimum standard of 3 per cent.

2. It would enable every consumer of such milk to know the minimum percentage of fat in each lot of milk purchased.

3. It would afford an opportunity for each consumer to purchase milk with the approximate percentage of fat desired, within reasonable limits, if there were any choice, and it would make it easily possible for the distributor or producer to furnish it.

4. It would protect distributors and producers against unfair competition.

5. It would have the tendency of helping to adjust or standardize the price of market milk in accordance with the composition of the milk furnished.

6. The successful employment of such a method would probably have the ultimate effect of making the sale of milk on a guaranteed fat basis supersede entirely the present minimum legal standard method for all kinds of milk, whether normal or adjusted.

ABSTRACTS AND REVIEWS OF DAIRY LITERATURE

City Milk Supply. HORATIO NEWTON PARKER. 468 pp. The McGraw-Hill Book Company, Inc., New York.

Instructors in city milk supply have long felt the need of a complete and up to date text book on the subject. Many of the books on various dairy subjects are really encyclopedias, covering many branches of the dairy industry, thereby making them poorly adapted to the teaching of one particular branch of the industry. Parker's *City Milk Supply* is, for the most part at least, an exception.

The author approaches the subject in a way which convinces the student of the importance of the dairy industry, of the great value of milk as a food and of the magnitude of the milk business. He then deals with the necessity of the sanitary production and handling of milk on the farm. The presentation of the facts relative to the diseases communicable in milk is exceptionally good. All the factors which affect the quality of milk at the time of milking and after the milk is drawn are fully discussed.

In only one place does the author diverge from the subject and present some information ordinarily covered in another course. This is in Chapter III, the first part of which discusses the various types and breeds of dairy cattle.

Having explained the sanitary production of milk, the course of the milk from the time it leaves the farmer until it reaches the consumer is carefully mapped out. The various means of transportation are described. The chapter entitled, "The Milk Contractor," comprising 142 pages treats fully with all the problems of the city milk plant. The treatise on pasteurization is up to date and thorough. Finally the various methods of controlling the chemical and sanitary requirements of the milk supply are discussed.

Not the least attractive feature is that at the end of each chapter there is a bibliography of the books and bulletins drawn upon for parts of the information contained in the chapter. This is a great aid to the instructor in assigning outside written work. The book is printed on an excellent grade of paper and contains sixty-three well chosen cuts. It is most sure to fill the needs of a course in "*City Milk Supply*."—H. F. JUDKINS.

The "Kingston" Cheese—A Cheese for Small-holders and Others. ALEX TODD AND WILFRID SADLER. Journal, Bd. of Agr., vol. xviii, no. 3, pp. 193-203, London, 1911.

The system adopted in making a small hard-pressed cheese, varying from 1 to 2 pounds in weight is described. By this system, a cheese is produced suitable for an average family; a cheese which embraces the qualities of a hard-pressed variety and yet one which is ripe and ready for consumption in ten to fifteen days after making. It may, however, if trade considerations demand, be kept in storage under suitable conditions for as long as six weeks. Since the outbreak of war, this cheese with others has been recommended by the English Board of Agriculture as a suitable variety to be made by those formerly making butter on the farms, as one means of food conservation.

The experimental work was carried out at the Midland Agricultural and Dairy College, Kingston, Derby, England.

Qualities. The cheese is a little softer than a Cheddar, and has a characteristic flavour; the texture is soft and granular embodying the features of a Cheshire and a Leicester, while to the touch it is soft and buttery; on boring with a trier, the fatty, smeary nature so typical of a mellow old cheese, is evident.

Utensils. The utensils required are in general those common in a cheese-making dairy or factory; if such need to be purchased, the initial outlay at pre-war prices averages about ten dollars per cow for a small dairy.

Process of making. Starter is added to the milk at the rate of 0.5 to 1 per cent. If a coloured cheese is desired, 1 ounce annatto to 400 pounds milk is desirable. A twenty-five second rennet test has given good results; at this acidity, and at a temperature of 84°F., rennet is added at the rate of 2½ ounces to 1000 pounds milk. When the coagulum is cut, the pieces of curd should be about ½ by ¼ inch. After cutting, the curd is left in the whey for some fifteen minutes before the cooking commences. The scalding or cooking must be gradual and the final temperature should be 90°F. Stirring is continued until the curd is sufficiently firm, when it is allowed to pitch. Usually the time from cutting to pitching will be one and one-quarter to one and one-half hours. The curd remains in the whey for twenty to thirty minutes; and when the acidimeter test is 0.15 to 0.16 per cent, the whey is drawn off. The curd is cut into 4 inch-cubes, piled, covered with cloths, and left for fifteen minutes. Again the curd is cut into similar cubes, turned in bulk and each cube broken into halves; this assists in the

expulsion of the whey, and has considerable influence on the 'short' texture so much desired in the final product. The turning and breaking is practised two or three times, but this is dependent upon the condition of the curd as regards dryness and acidity. No pressure is applied, as the curd must not be allowed to 'matt' as in a cheddar.

When ready for grinding, the test on the hot iron is about $\frac{3}{4}$ inch, or the acidimeter test 0.5 per cent, this stage is usually reached one hour after the drawing of the whey. The curd at this stage is soft and velvety to the touch, and should break short, with no tendency to toughness. It is milled to a fine state, and on pressing a handful of curd it should be moist, mellow, and free, with a smaller amount of excess moisture than a Derby, yet more than is required in a Cheddar curd. Salt is added at the rate of 1 ounce to 3 pounds curd, and moulding is done at once; the weight of curd will vary, but the average yield is $1\frac{1}{4}$ pounds to $1\frac{1}{2}$ pounds per gallon of milk. The cheese are at once put under press, the acidity on the acidimeter being 0.5 to 0.6 per cent. The moulds are made of well-tinned metal, 4 inches in height, diameter $3\frac{1}{2}$ inches, the bottom of the mould is closed except for a hole in the centre $1\frac{1}{2}$ inches diameter; a loose tin follower is used in the bottom and a wooden follower is needed to cover the curd at the top.

The cheese are left under press for two hours with the dead weight of the press applied; they are then turned and pressed again for a further two hours with a little additional weight. The pressure is released, the cheese again turned, and allowed to remain in the moulds for some eighteen or twenty-four hours. They are then smoothed up with a palette knife and bandaged with calico and paste, or if more convenient they may be smoothed up and paraffined. The cheese are removed to the ripening room; good results have been obtained by ripening at a temperature of 60° to 65°F. when the cheese are required to mature in ten days. If they need to be kept for a longer period, they must be removed after the first few days, to a cool or cold room. Usually one pound of ripe cheese is produced per gallon of milk.—WILFRID SADLER.

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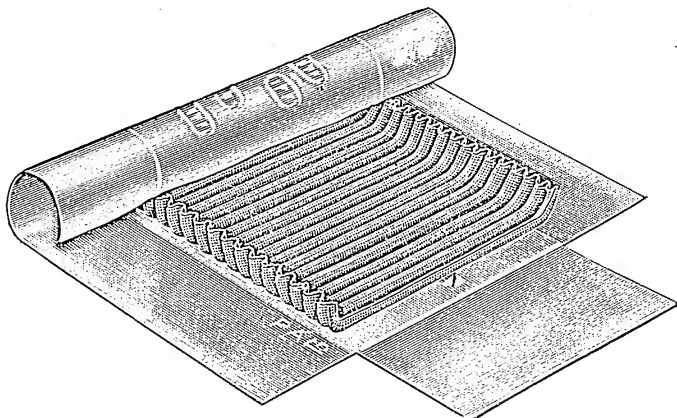
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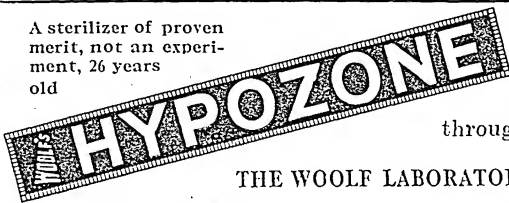
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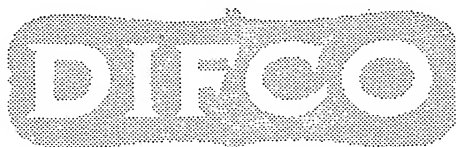
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THE JOURNAL OF DAIRY SCIENCE is issued bi-monthly, appearing in January, March, May, July, September and November. Each volume will consist of approximately 600 pages. Subscription is by the volume only and not by the year. One volume a year is issued at present.

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Of Interest to Authors and Editors

A Plea for Coöperation

To effect greater economy in production costs and production time contributors are respectfully urged to observe the following rules when preparing manuscript for publication in this journal.

Copy. All copy should be typewritten upon white paper, 8½ x 11 inches. It should be typewritten upon one side only and sent to publishers flat, not rolled or folded.

Composition of matter in different sizes of type is done on different machines. Therefore, footnotes, reference lists, tables, quotations, and all other matter that is to be set in different type from that of the text, should be typewritten upon separate sheets.

Quotations. Quotations of four full lines or more are set in smaller type than the text proper; quotation marks are to be omitted.

Each individual quotation should be typewritten upon a separate sheet of paper.

Footnotes. While there are exceptions, as a rule, footnotes are not desirable. Descriptive or explanatory matter can almost invariably be incorporated in the text. Bibliographical references should be placed at the end of the paper under the heading of "References."

Where footnotes cannot be avoided, they should be numbered consecutively for each paper, typewritten collectively, and placed at end of manuscript. They will be placed upon proper type pages when the article is pagged.

References. References are numbered consecutively in the order of their appearance in the text and are printed at the end of the article under the heading of "References." Text references to this list are indicated by numerals in parentheses instead of the superior figures used for footnotes.

The system of abbreviations adopted is that employed in the "Index-Catalogue of the Surgeon-General's Library," and the style adopted by the American Medical Association.

The author's initials are important, but not his titles or degrees. Therefore, be sure to supply the former and omit the latter.

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Abbreviations. Obscure and misleading abbreviations should be avoided.

As the metric system is of universal usage by research workers, it is desired that such abbreviations as "mm.," "cc.," "mgm.," "kgm.," etc., be used in all cases when preceded by a numeral; e.g., "10 mm.," "5.05 cc." They should be spelled in full when not preceded by a numeral.

Periods of time are usually expressed in round numbers, and as such should be spelled out; e.g., "ten to twenty days."

The symbol of percentage (%) is not to be used, but to be spelled as "per cent."

The word "gram" is variously abbreviated as "gr.," "gm.," "grm.," or "g." Likewise the word "grain" is abbreviated as "gr.," "grn.," or "g." To avoid possible confusion the words "gram" and "grain" are to be spelled in full in all cases.

Tables. All tables of two or more columns are ruled. Care should be taken that as few cross rules as possible are used. Such rules add greatly to the cost of composition and in most instances a blank space will answer the same purpose.

Tables should be numbered with Arabic numerals in consecutive order from 1 up.

Each individual table should be typewritten upon a separate sheet of paper.

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Usually unmounted and untrimmed prints are preferred, but when a composition illustration is employed the prints should be pasted upon heavy cardboard and dried under pressure to prevent wrinkling.

The important feature of a photograph often occupies a few square inches in the center. If this part is indicated by light pencil marks, much expense can be saved by avoiding the reproduction of unessential backgrounds.

General. Alterations are expensive. In a few instances they are necessary, but where an author uses the proof sheets to put finishing touches upon an article, it is only reasonable that he should pay for the alterations.

From the receipt of copy by the editor to the time of actual printing, the slightest error or lack of clarity in copy is likely to cause delay and useless expense. Authors are, therefore, strongly urged to read and revise all manuscripts with the utmost care before sending same to the editor.

To aid authors in the proper presentation of manuscript we have prepared two pamphlets, "How to Prepare a Paper for Publication." and "A Brief Technical Talk." Both will be gladly sent free of charge upon request.

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ANNOUNCEMENT

This issue of the JOURNAL OF DAIRY SCIENCE is devoted to the Proceedings of the Twelfth Annual Conference of the American Dairy Science Association held at Columbus, Ohio, October 22, 1917.

In accordance with the expressed wishes of members present and a ruling by President W. A. Stocking, the discussions following each committee report, as well as the report itself, are published for the benefit of JOURNAL readers.

Many members of the Dairy Science Association are availing themselves of the opportunity to publish advance reports and progress made with various experimental projects now under way. This tendency is strictly in line with the desire of the United States Department of Agriculture and Food Administration who are putting forth every effort to make all scientific data immediately available to help out war emergencies. Since dairying represents one of the great fields of food production, every scientific fact that may advance dairy science should be given to co-workers at the earliest possible moment so that practical application may be made thereof as soon as possible. Too often important data has failed to reach those interested because of lack of funds for printing, or perhaps because the material was not adapted for bulletin form.

The JOURNAL OF DAIRY SCIENCE, it is hoped, will be considered the logical medium through which such scientific data can reach co-workers in the dairy world, and I wish to assure the readers that the editorial board will give careful consideration to all contributions sent it.

The editors consider that the Open Forum Department should be an important feature of the JOURNAL and inasmuch as this department offers opportunity for the wholesome discussion of new ideas and observations as well as practical application of new scientific work and the discussion of new methods for the presentation of these facts for instructional purposes, it is hoped

that readers of the JOURNAL of DAIRY SCIENCE will contribute freely to this Department.

The value of the JOURNAL will be in proportion to the contributions made to it, for only with an abundance of material from which to select can the editors maintain the high standard which I am sure is desired by every member of the Association.

J. H. FRANDSEN,
Editor-in-chief.

TWELFTH ANNUAL CONFERENCE OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

COLUMBUS, OHIO, OCTOBER 22, 1917

The conference was called to order by the President, Prof. W. A. Stocking, at 2 p.m. in Memorial Hall and the following program was carried out:

Roll Call of Members

Minutes of Last Meeting

Reports of Committees

1. Legal Limits for Butter. B. D. White, *Chairman*, Winkjer, Benkendorf, Cunningham.
2. Course of Instruction for Dairy Inspectors. Oscar Erf, *Chairman*; Van Norman, Wing, Woodward, Harris, Buckley.
3. Bacteriological Methods for Market Milk Analysis. R. S. Breed, *Chairman*, Rogers, Hastings, Supplee, Hammer.
4. State and National Brands for Butter and Cheese. M. Mortensen, *Chairman*; Lee, C. Larsen, Hepburn, Fisk.
5. Dairy Farm Score Card. Ernest Kelly, *Chairman*, Lane, Stocking, Weld, Harding.
6. Statistics on Production and Marketing Dairy Products. R. C. Potts, *Chairman*, Hunziker, Thompson, Lee, Davis.

Address by H. E. Van Norman, President of the National Dairy Show.

Banquet. 6.30 p.m. October 22, 1917. The Busy Bee Restaurant, Columbus, Ohio.

Election of Officers.

Report of Students' Dairy Cattle Judging Contest. Helmer Rabild, U. S. Dairy Division.

Report of Dairy Products Judging Contest. W. P. B. Lockwood, Mass.

Address, by B. H. Rawl, Chief of U. S. Dairy Division.

Song—America—by Audience.

Adjournment.

LEGAL LIMITS FOR BUTTER¹

B. D. WHITE²

Boston, Massachusetts

Your Committee begs leave to report on the legal limits for butter as follows:

We recommend 80 per cent butter fat, 16 per cent moisture and 1.25 per cent casein. No tolerance should be allowed. This limit should be applicable to both salted and unsalted butter.

Since it is possible to test for moisture, allowing 1 per cent for casein, the ordinary buttermaker can with a reasonable degree of accuracy determine the per cent of fat in his butter without the necessity of analyzing the same for that purpose.

The question of allowing a higher percent of moisture for unsalted than for salted butter has been discussed, but since the butter fat is of intrinsic value, and unsalted butter commands a higher price than salted butter, it is not deemed wise by your Committee to have one standard for salted and another for unsalted butter.

Your Committee further begs leave to report that if there is to be a tolerance, the butter fat in the butter should be increased to the extent of the tolerance.

Your Committee is also inclined to believe that the casein is of minor importance and may be omitted entirely, if the Association deems it expedient to do so.

DISCUSSION

In the discussion which followed the reading of this report Professor Hepburn raised the question as to whether or not it would be wise to make any specific recommendation regarding the amount of casein. Professor Mortensen thought that any action taken should be in harmony with the action taken by the National Buttermakers' Association at their meeting at Milwaukee.

¹ In the absence of Mr. B. D. White, Secretary M. Mortensen read this report.

² Chairman of committee.

Professor Frandsen suggested that since there are some differences regarding certain phases of the Standards, no definite recommendations be made by the association at this time.

Motion that the report be duly received and filed was made and carried, with the understanding that the Committee continue its work relative to the fixing of Standards.

BACTERIOLOGICAL METHODS FOR MARKET MILK ANALYSIS

R. S. BREED¹

Geneva, New York

During the past year this committee has continued to co-operate with the Committee on Standard Methods appointed by the American Public Health Association, whose final report has just been approved at the meeting held during the past week in Washington, D. C.

In the course of this coöperative work it has become increasingly evident that this latter report, drawn up as it is with the primary purpose of standardizing those methods of analysis which are useful in control and inspection work, would not meet the needs of the members of this Association. As a group the bacteriologists included in the American Dairy Science Association are primarily interested in research work, one of their functions being that of providing the dairy interests with analytical methods suitable for commercial purposes.

At the present time, all of the market milk sold in New York State and much of that sold in other states, is graded according to certain established standards of quality. A greater uniformity in these systems of grading will be secured as soon as there is a general recognition of the desirability of such grading accompanied by an elimination of those systems of grading which are founded upon false ideas of economic conditions. We hope that the report of your Committee on Milk Quality which is to be presented at this meeting will do something toward hastening the establishment of a better and more uniform system of grading milk.

Underlying any system of grading there must be suitable analytical methods for determining variations from the standard quality. Such methods as are needed for commercial use in

¹ Chairman of Committee.

grading the food value of milk are already well known and the work done by our committee on the Babcock Method has been of great value in securing greater uniformity and standardization of the most useful of these methods. With the approval of this Association your committee on Bacterial Methods proposes to undertake a similar work for these analytical methods which are suited for determining the variable qualities of market milk which are related to the presence or absence of bacteria.

Such a work will require time and additional research as our present available methods fail in many places to meet the needs of commercial interests. The final report ought not to duplicate the Report of Committee on Standard Methods of the American Public Health Association and ought at the same time to be of help to the dairy industry in meeting fair and just standards of quality.

DISCUSSION

Professor Breed, supplementing his report said: "It seemed to some of us that there was a need for methods which were of particular use to the commercial man rather than of special value for inspection work. The American Public Health Association is interested primarily in judging the quality of milk that is supplied to consumers. The commercial interests are primarily interested in controlling the market—controlling the milk before it is supplied to consumers, and they must have special methods of doing it, or else they work blindly; but in some localities the methods would be a somewhat high test, and it is best that we work out a report that will be helpful and of benefit to the commercial interests."

In discussing the report Professor Harding said: "It seems to me this should be decided or could be decided by some committee on methods. As has been noted there has been reported the activity of the committee on methods of the various associations, and it seems that they could deal with this larger method for determining the element relating to bacteriology. I am perfectly willing that the policemen shall have methods of doing their work which shall be exhaustively correct. I don't object

to their having methods of that sort, but the thing I do object to strenuously is to having that policeman, or those police methods taken as official methods. The men may go into the bacteriological question and know what the methods are; but lots of them get the police methods and get the idea that is the way, and it is a serious question to find that a number of them are misled by application of this so-called police method. I think that in order to save the situation we should take up these methods for investigation. I am frank to say that in order to get that investigation you have to adopt methods—there are unfundamental methods which perhaps are not as good as police methods, but something ought to be done to recognize the official methods, and I think this matter should be taken up."

President Stocking said: "It seems to me that the Association is especially fortunate in having as Chairman of the Committee on Bacteriological Methods a man who is also a member of the American Public Health Association so that we will be practically beyond running contrary to methods which they may consider and our committee will have the benefit of the discussion which takes place and the action which may be had by the Public Health Association; but I have felt for a long time as Dr. Harding has expressed himself, that there is a vast difference between the real work the Public Health Association is attempting to do, and the work that this Association is trying to do, and it is not very advisable, if at all advisable, to make methods which are applicable identical for the two problems. I think there is a big value in the work of this committee, and I think that we were extremely fortunate in having the work in such good hands as it is in now."

Professor Breed explained that there are two members of this association who are members of this committee on standardization methods, Professor Harper being the other member appointed on this committee.

Motion that the report be adopted was carried.

STATE AND NATIONAL BRANDS FOR BUTTER AND CHEESE

M. MORTENSEN¹

Ames, Iowa

The following is a continuation of the report presented by your committee a year ago. During the past year the work of promoting the state trademarks for butter in three states, Minnesota, Michigan, and Iowa has continued with as much success as could be expected.

MINNESOTA TRADE MARK

In reference to the work in Minnesota Hon. Jas. Sorenson, State Dairy and Food Commissioner, in a letter dated October 3, 1917, writes as follows:

We now have fourteen creameries scored for and twelve that are operating under our state brand law. We are all talking better quality of dairy products, and I consider our state brand law the best thing we have on our statute books for accomplishing this result.

In order that a creamery may comply with the requirements and use this brand, all dairies supplying milk must be inspected and receive an average score of at least 50 out of a possible 100 for the B brand and 60 points for the A brand. This puts the dairy inspectors in personal contact with the dairy farmer, which I consider the great factor in making a success of the brand law, because it has resulted in improvement of the raw material delivered to these creameries. Starting improvements first on the farm is the only way to accomplish true dairy reform. It takes good men and money to carry on this work of scoring for the state brand. On account of lack of funds, this work has not been pushed as much as it should be by this department the last few months, but we hope for more effective work the coming year. We have a number of applications on file for state brand scorings which we have so far not been able to comply with. In order to keep up the effectiveness of this work, the dairies should be rescored at least once each year.

¹ Chairman of committee.

Next in importance to the state brand law, I would consider the standardization of quality of the finished product from the factories. This, I think, could best be accomplished in smaller units, say, for instance, in county organizations. This has been attempted by the buttermakers of Meeker County, this state, during the past few months. Mr. Alfred Anderson, of Champion Butter Culture fame, has devoted most of his time this summer to helping the boys make a uniform quality of butter.

They have also tried to some extent to sell their butter to the same concern. I am not definitely informed as to results.

MICHIGAN TRADE MARK

In reference to the work carried on in Michigan, Mr. H. D. Wendt, in Charge Dairy Division of the Michigan Dairy and Food Department, in a letter dated October 1, 1917, writes as follows:

The Michigan Dairy and Food Department has prosecuted this brand proposition vigorously ever since the enactment of our Trade Mark law in the 1915 session of the Michigan Legislature, and as a whole, progress is satisfactory. We have found, however, that progress is considerably interfered with from within the industry itself, and under conditions prevailing since our entry in the war, it is doubtful if much progress can be made.

I have been most bitterly disappointed in several phases of the work. One is the apparent lack of coöperation on the part of the distributors which simply indicates that in order to make the brand of any value to either the creameries or the consumers, new marking machinery must be set up. On the other hand, with conditions as they existed during the storage season just closed, with receivers and storers of butter paying a premium over the quotation of Extras for ninety point butter, confident in their ability to market this grade of butter at top prices, and in which they are apparently successful, the problem of the small creamery looks difficult indeed.

We have granted a license to twenty-one plants thus far. Quite a number of them are still working on navy contracts so it is difficult to measure the value of the brand to these particular creameries because their butter has not been on the open market. No changes have been made in our rules and none are immediately contemplated.

IOWA TRADE MARK

In Iowa only four creameries have qualified for permission to use the Iowa state trade mark. Others are trying for the brand at present and it is reasonably certain that two more will qualify before long. It has been the policy in Iowa to score the butter from each churning for several weeks before permission to the



TRADE MARK ADOPTED FOR FIRST QUALITY IOWA BUTTER

use of the trade mark is granted. One creamery which recently qualified was sending trial samples for several months and it was evidently due to this training that the same creamery won the highest score at the National Convention held at Milwaukee this year.

STATE AND NATIONAL TRADE MARK

Only the three states mentioned have up to this time employed the use of a state trade mark for butter. Report in reference to cheese was given a year ago by Prof. W. W. Fisk, Cornell University.

Your committee is of the opinion that a state trade mark should be of much value to be used for butter and cheese and the use thereof should be encouraged in other states where this system of recognizing quality has not yet been introduced. The question, however, in reference to a national standard will require a great deal more consideration before your committee will be ready to make definite recommendations. It is recognized that the American butter must be standardized, and in that work the state organizations will evidently be the leading factors. It will be quite possible and evidently most desirable that each state use its own trademark and when the creameries have qualified for the use of their state mark it will be comparatively easy to standardize such creameries of all states so that the butter made in those various creameries will be of uniform quality although it is differently branded.

The state trademark should always be held as the seal of high quality and as such it will be a prize which every creamery will be anxious to work for. If it is not kept up to that standard then it is not merely worthless but it is even a detriment to the state using it.

Considering that the trade marks for butter are kept up to a high standard it is evident that it will be a long time before all our creameries will qualify or even attempt to qualify. It is therefore realized that some other system for standardization should be adopted, not to take the place of the state trade marks, but a system which will be a stepping stone to the trade mark and which will furnish more immediate relief.

The butter from the smaller creameries is often sold for less than it should sell for due entirely to its lack in uniformity. The centralizing creameries are not on the average making a fancy butter as is made in most of the small local plants. Nevertheless the butter from the centralizing factories will often sell for more money than is realized on the superior butter from the smaller creameries for the reason that the products from the larger plants are of uniform quality. If we expect to uphold the local creamery it will be necessary that we help it to get into a position so it will be able to standardize its products for if not the larger plants will eventually become too strong as competitors.

The one who is not convinced of the lack of uniformity existing in the American butter should step into the butter exhibit hall at one of our national conventions. If the same person could then later step into a butter exhibit hall in Denmark or in Holland he would soon be convinced of the difference. In the European butter such points as body, color, salt and package are practically identical and the difference in flavor is discovered only by an expert. We need only to visit our Northern neighbors in Alberta and Saskatchewan in order to find what we would consider uniformity. The creameries in these provinces were confronted with the problem of marketing. They were manufacturing more than could be disposed of locally; the export market was the only one available to them but in order to establish a foreign market it was necessary to have the product standardized. America is about the only country which has been willing to accept our butter as it is but it will not be very long until we will find that even our own country will not continue to accept our products unless we are able to do the same as all other manufacturers do "Standardize our Products."

BUTTER CONTROL IN ALBERTA AND SASKATCHEWAN

Improvements most often come as a result of necessity. It seems to be most natural for us to follow the road of least resistance. We are doing so today in reference to buttermaking and so they did in Canada until they were facing the problem of having an oversupply of dairy products. They realized that there was a good market for these in England if they could produce the goods which that market demanded but it was soon discovered that the Alberta and Saskatchewan butter did not come up to that high standard. Immediately the Dairy Commissioners of the two provinces started their work of improving and standardizing their products and through the effort of Commissioners C. Marker of Alberta and W. A. Wilson of Saskatchewan and Prof. K. G. McKay of the University of Saskatchewan the butter was not merely improved but it was also standardized to such an extent that today about per 50

cent or more of their butter is of uniform quality. Their butter has been exported to England with the satisfactory result that it was reported to be equal in quality to the Danish butter.

It is claimed by the dairy authorities in Alberta and Saskatchewan that the success obtained by the creameries of these provinces is largely a result of their system of grading the butter. Each of the two provinces are maintaining two butter grading stations. It is not compulsory for the creameries in either of the two provinces to send their butter to the grading station. Creameries in Alberta desiring to have their butter graded sign an agreement with the government whereby the creamery agrees to send a 14-pound box of butter from each churning to the grading station. These boxes are marked to correspond with markings on boxes from the same churning offered for sale. In addition to one or more letters indicating the creamery in which the butter is made the boxes also bear the serial number of churning and number indicating the date on which the butter was made. The dairy commissioner agrees to score the butter and to issue a government score card and to mail a copy of this to the buyer of the butter and a duplicate to the manufacturer, while a third copy is filed in the office of the dairy commissioner. As the buyers have become educated to the government score card most of them demand that the butter shall be bought on the government score card. For that reason about 90 per cent of the butter sold in Alberta is sold on the government score card, according to a statement made by Commissioner Marker. The price paid for butter varies in accordance with the score, about half a cent per pound being deducted for each point below "special." No government certificate or score card is issued for butter made from raw cream. The government buys the butter samples at a nominal price. These are held in cold storage for not less than one month as the samples may be needed in settling disputes between the buyer and the seller. If the manufacturer, after a month's time, desires to have his samples returned then he has the privilege of buying same for one cent more than he received from the government. This extra cent is supposed to pay for some of the expenses incurred in handling the butter at the station.

The system of grading in the Province of Saskatchewan differs from the system adopted in Alberta inasmuch as the former province has the entire shipment sent to the grading station where it is graded, and from there it is usually sent in car load lots to the market. In accordance with the Saskatchewan system the creamery will not necessarily have all of the output graded, but only that part which is shipped. What is sold locally will not be graded. The system in Saskatchewan is in a way cheaper so far as the grading is concerned as it will take fewer judges. This system is something similar to the system adopted in New Zealand where only butter that is to be exported is graded.

The chairman of your committee inquired from Mr. Marker of Alberta in reference to the success which they had obtained from their system of grading. He informs me that it is due to this system that their butter has reached its present high standard. I looked over some of his office records from which I found that for the week ending August 11, 1917, thirty of the Alberta creameries sold their entire output on the government score card as against twenty-seven creameries for the corresponding week in 1916. It is quite remarkable to know that all of the larger plants have taken advantage of the government grading station for although only about 50 per cent of the creameries have their butter sold on grade, these manufacture about 90 per cent of the total amount of butter manufactured in the province. I found that the butter for the week of August 11, 1917 graded as follows:

- 69.2 per cent graded specials
- 24.6 per cent graded first
- 5.0 per cent graded second
- 1.2 per cent off grade

This represents 461 lots or 301,505 pounds.

During the corresponding week of 1916, 410 lots were graded representing 248,535 pounds of which,

- 48 per cent graded specials
- 38 per cent graded first
- 12 per cent graded second
- 2 per cent off grade

The above seems to indicate that the quality is improved by their system of grading and likely as a result thereof greater interest is manifested by creamery operators as they find it difficult to sell the butter except on grade certificates.

The Alberta butter is classified under the following grades.

"Special" grade, scoring 94 to 100 points, minimum for flavor 41 points.

"First" grade, scoring 92 and under 94 points, minimum for flavor 39 points.

"Second" grade, scoring 87 and under 92 points, minimum for flavor 37 points.

"Off" grade, scoring under 87 points.

In order that creamery butter may qualify for "Special" grade certificate it must have been made from pasteurized cream and otherwise closely conform to the following description, which represents in a general way the requirements of the markets in which the great bulk of the Alberta product is consumed:

Flavor: Fine, sweet, mild and clean.

Texture: Firm and fine; clear, but not excessive, free moisture.

Color: Uniform and of a pale straw shade.

Salting: About 2 per cent, thoroughly dissolved and incorporated.

Package: Well-made box of export type, clean and evenly coated with paraffin wax on the inside surface and properly branded. Good quality of parchment paper linings, neatly arranged. The butter is to be solidly packed, full weight and with a smoothly finished surface.

The cream purchased is graded to correspond with the butter standard. Cream grading as "Special" is cream of such quality as will produce butter of special grade. First grade cream will produce first grade butter, etc.

BUTTER CONTROL IN NEW ZEALAND

New Zealand demands that all butter exported is inspected by a government inspector. There are nine such inspectors employed in New Zealand or one inspector for each shipping

point. This inspector scores one package of butter from each churning. A certificate is issued for each shipment. A copy of this certificate is sent to the manufacturer of the butter, a second copy is sent to the purchaser of the butter and a third copy is mailed to the government inspector in London. The grade of the butter is also stenciled on the package and the merchant buys the butter on the basis of such markings.

In order that the government inspector may obtain a package from each churning it is ordered by law that all packages must be marked at the factory with the date when the butter was made and the number of the churning; each factory is furthermore required to keep a permanent record of such marks. If the package is marked "No. 5, June 2," that means that it is from the fifth churning made on June 2d.

In addition to such marks each package is also marked with the registered number of the creamery and each creamery exporting must be registered.

After the butter has been scored by the inspector in New Zealand it is required that it be placed in cold storage for not less than four days before it is loaded into the boats for shipment. A special inspector is located in London, England. This man has for several years been inspector in New Zealand and it is his duty to examine the butter when it arrives in England and if the butter has deteriorated while in transit or is of a different grade than that marked on the package he notifies the government immediately. In urgent cases he is allowed to cable. In order that the inspectors of New Zealand may be in a position to do uniform work all the inspectors come together about three or four times annually and at such annual conferences they do considerable scoring so they may all have the same standard.

The New Zealand inspectors will also take samples for moisture tests. All butter sold must contain less than 16 per cent moisture. The inspectors will furthermore weigh 5 per cent of the butter exported. If the butter is weighed with the parchment paper liner then they are supposed to allow 8 ounces on a 56-pound package, figuring 4 ounces for shrinkage and 4 ounces for the parchment paper liners.

BUTTER CONTROL IN HOLLAND

The Holland system of butter control is based entirely on the chemical analysis of the butter. The purpose is that of preventing the creameries from adulterating the butter either with moisture or foreign fats. It is claimed that some years ago such adulterations were quite frequent in that country.

The inspectors take at the creameries, samples of butter wholly made under their supervision. Such samples are taken at irregular intervals. All samples are analyzed at the laboratory. All butter, when shipped must bear the government mark upon which by means of numbers and letters the maker as well as the date of making are indicated.

Notwithstanding the varying chemical composition of genuine Netherland butter, the butter control station concerned, can from the available data, give the chemical composition of control butter wherever and whenever such butter is found at home or abroad, provided only that the number and letters of the government label found on the butter be mentioned. It is evident that the genuineness of the butter can be established from a reasonable agreement of the analytical figures given by the control station with those found for the analyzed butter.

Since 1904 the Netherland government has authorized the butter control stations to use the above mentioned government butter mark. The government has prescribed certain well defined rules and conditions for the butter control stations and their members and government officials watch that these conditions are strictly followed up; in this way the butter control stations are under government supervision and enjoy the support of the government.

There are eight control stations in Holland. These stations employ a director who is the chief chemist and he usually has two helpers and a couple of men travelling through the country collecting samples. The chief station in Holland is at Leiden. At that place marks used for the butter are manufactured. A record is kept of all of the marks sent out to the various stations. The sub-stations in return send information back to the Leiden

Station in reference to the disposition of the stamps giving the number of stamps sent to the various creameries.

The Holland control stations are private, but work under the supervision of the government. The creameries bear the cost themselves pro rata to the amount of butter produced.

The paper marks used as identifying marks are made from casein and they are so perforated that when pressed into the butter they are not able to be removed and can therefore be used for only one package. The trade mark bears the Netherland coat of arms and has the writing "Nederlandsche Botercontrole" and each mark is numbered.

The society can refuse the admission of anyone who makes application for becoming a member without giving any reason for such a refusal. Manufacturers who become members must be persons of good reputation and such as are not identified with the manufacture or handling of oleomargarine or foreign oils.

Although this mark does not in a way indicate the quality as we usually understand the term, at the same time the English people will not accept butter from Holland unless it bears the government mark.

BUTTER CONTROL IN DENMARK

The Danes are using a special mark known as the "lure mark." Each firkin which is used for the Danish butter contains two staves with the Danish lure mark. Staves bearing this mark are furnished by the main office of the Association. In addition to these special staves parchment paper bearing the lure mark and special numbers are furnished by the Association. One of these slips is placed inside in the bottom of the container and another one on top of the butter. A complete record is kept at the main office of the Association of the quantity of slips and staves sent to each creamery and the numbers with which such slips are marked. It is furthermore required that the creameries keep a complete record of the use of such labels and show where butter marked with the labels has been marketed.

In accordance with the Danish law no butter may be exported which has not been pasteurized to a temperature of not less than 176°F. and furthermore it must be properly marked with the Danish lure mark. It is possible, however, to ship print butter packed in hermetically sealed cans without such markings. All used firkins must be destroyed.

Anyone desiring to obtain the privilege of using the Danish lure mark must make request therefor in writing to the police station.

Any creamery that has the privilege of using the Danish lure mark is required to forward butter to the Danish Experiment Station whenever called for by that station. Calls are usually made by telegram or by special delivery letter and the butter must be sent immediately upon receipt of such notice. The package of butter to be sent must be from the churning made immediately before receipt of the notice. Such calls will be made from two to three times annually. The country is also divided into districts and each district has eight scorings annually. The buttermakers are required to exhibit butter for such scorings. If a low score is obtained by a creamery the experiment station in Copenhagen will be notified immediately and special calls for butter from such a creamery are made by the experiment station.

If the creamery scores five points below the average score when sending butter to the laboratory in Copenhagen, such a score is reported to the Secretary of Agriculture and special efforts will be made toward having the creamery improve the butter. A number of calls for butter from that creamery will be made and if they after a short time find no improvement the lure mark will be taken from the creamery and it will be impossible for such a creamery to export any butter and practically no sale exists for such butter in Denmark. In fact a creamery from which the lure mark privilege has been taken will practically have to go out of business.

The scoring at the dairy experiment station is done by three sets of judges. Each set of judges is composed of three men, one state inspector, one butter dealer and one buttermaker.

The butter when called for is left at the experiment station for two weeks at a temperature of 50°F. before it is scored. Their object is to score the butter at about the same time and in the same condition as it would reach the consumer.

WORK TO BE RECOMMENDED FOR THE IMPROVEMENT OF BUTTER
MANUFACTURED IN THE UNITED STATES

The chairman of your committee has for a long time considered the need for improvement of the Iowa butter and after studying conditions in Alberta and Saskatchewan I am fully convinced that we can accomplish the most work at the lowest cost by organizing butter grading stations. I have recommended that we in Iowa start two such stations, one to be located at Mason City and another at Des Moines. Each grading station should be started with one capable butter judge who could grade the butter and send out the necessary reports. One report should be sent to the butter buyer immediately, a copy should be mailed to the manufacturer, while a third should be placed on file. After the butter has been scored it should be stored for one month and then rescored for the purpose of determining the keeping qualities. A report of the rescoring should also be sent to the manufacturer and a copy thereof placed on file. If a sample is found to be of poor keeping qualities then a part of this sample, about 8 ounces should be sent to the experiment station for analysis so that we may be able to lend assistance to the manufacturer.

It has furthermore been recommended that we be ready to add to the force at the grading station whenever necessary and to establish grading stations in other parts of the state whenever the demand for such work has increased sufficiently.

In addition to this work we should encourage coöperation among the local creameries by encouraging them to join together for the purpose of employing an expert buttermaker who can assist the various creameries in standardizing the products of the creameries and gradually improving the quality. Such an expert should be employed for the annual output of 3,000,000 to

4,000,000 pounds of butter. He should stand in close touch with his experiment station and with his state dairy commissioner and should give immediate attention to defects in quality reported from the grading station. It is also possible that this expert eventually takes care of purchasing of supplies which can be done to best advantage if bought collectively.

The question has been asked, will such stations mean a profit to the American dairymen if established in the United States? We have no data from this country by which to prove that it will. We have, however, information from other countries. Alberta manufacturing about 7,000,000 pounds of butter annually can support two grading stations with two graders and one assistant for each station. New Zealand manufacturing less creamery butter than the State of Iowa is supporting nine grading stations and a special inspector located in London, England. Mr. S. Lowe, the senior member of the produce firm, W. Weddell and Company, one of the biggest produce firms in England made the statement to the writer three years ago that it was due to the New Zealand system of grading that their butter had attained a high reputation on the English market. This statement was confirmed by Mr. Wright, the New Zealand Inspector in London. The butter manufactured in Alberta and Saskatchewan holds the record today for being superior to the butter made in any other province of Canada. Dairy Commissioner C. Marker of Alberta, Dairy Commissioner W. A. Wilson of Saskatchewan, and Prof. K. G. McKay of the Dairy Department, University of Saskatchewan all inform me that their success has been obtained through the grading stations. Similar results have been obtained in Denmark and Holland. If the grading station has thus been a success every place where it has been introduced up to this time it would seem reasonable for us to expect equally satisfactory results if it is introduced in the United States. Your committee therefore recommends:

1. That the committee on state and national trade marks be discharged and that a new committee on standardization of American butter be appointed.
2. That this new committee shall encourage the establishment

of butter grading stations in the various states and encourage coöperation of creameries for the purpose of hiring an expert to supervise the output of a group of creameries.

3. This committee shall endeavor to secure the good will and coöperation of the butter dealers for the promotion of the proposed work.

4. The committee shall furthermore coöperate with other interested bodies such as the National Buttermakers Association, The Association of Dairy and Food Commissioners, the various state organizations, The Dairy Division and The Bureau of Markets, Washington, D. C. We should expect assistance from all these bodies if the matter is properly presented to them.

5. This committee should finally coöperate with butter boards and organizations above mentioned in establishing a commercial standard for American butter. In establishing such a standard it should be remembered that the commercial standard for creamery butter in Canada is 94 and about the same in the European countries. It would be an insult to the American creamery and the American buttermaker to propose a lower standard for American butter.

DISCUSSION

In opening the discussion of this report Professor Mortensen said: "You may object to having a comparison made between the conditions in this country and those of Saskatchewan and Alberta as Edmonton, Alberta is about 1000 miles north of Ames, Iowa. It is well known, however, that the summers there are fully as warm as are our winters and it has been my experience that the quality of our butter is not improved very much during the winter months.

While at Calgary we were asked to judge butter purchased by a buyer from this country. He was buying butter from creameries that were not grading. This butter averaged from 88 to 86 points which was quite a contrast from the butter that we had graded before from the creameries that are grading and are having their butter graded by the grading station.

The information presented in reference to the conditions in New Zealand were obtained from Mr. Wright, the New Zealand inspector in London, England. Mr. Wright was formerly butter inspector in New Zealand.

The greatest defect in the American butter is that it does not possess keeping qualities. I examined butter in Alberta that had been kept in cold storage for eighteen months and it still appeared to be fresh. I hope to have a sample of this butter exhibited at Ames during the winter short course. I made an effort to have it here for this meeting, but I found it impossible to make the proper arrangements. It is my opinion that if they are able to produce butter possessing such keeping qualities in Alberta we can do the same here, but in order that it may be accomplished it will be necessary that we adopt definite rules and see to it that such rules are being enforced throughout our creameries.

I wish to state that at the National Buttermakers Convention a committee was appointed to take this matter in charge. This committee consists of three men, so if a similar committee is appointed by this Association there is an organized body of buttermakers with which it can coöperate."

Professor Potts said, "I consider the paper just read to be full of the best things that the Association has ever had presented to it. Having been in the Department of Agriculture for three years studying butter making, as well as some other branches, I want to say there is a lot of food for thought, for serious thought, in that article, and in the recommendations made by that committee. I am sure that it is a step in the right direction, and that the salvation of the dairy industry of this country today depends upon such action being taken as was recommended in that report. I want you when you go home to read that report through when it is published, and think seriously of carrying out some of the recommendations which they give, because I think they are right."

Professor Van Norman continuing the discussion said, "I want to emphasize the other end of the game. We are talking here now about the makers' standards and trade marks, and

their marketing their products. The thing that makes a trade mark valuable is that the consumer derives an understanding of that trade mark, and progress will come just in proportion to the number of creameries that can put it on, and the place we can make for them. This brings to my mind Mr. Powell who spoke this morning; as most of you know he is associated with Mr. Hoover, and he is a man who has appointed seven inspectors as well as two who put the trade mark on oranges, and I don't suppose there are any who have not heard of "Sunkist" oranges. When you have a high grade and have a trade mark, the consumer learns the grade, and wants that high grade, and you must uphold this high grade, and it is the dealers' ambition to make the—those who use the trade mark—goods reach the high standard."

Professor Mortensen said, "I think it is essential that there should be coöperation between the producer and the manufacturer and the consumer, and the merchant and the consumer. It is also important that we have this in mind, and I think that advertising eventually will be essential. We did not incorporate it here, owing to another tax which would be placed on the creameries in employing an expert. I feel certain that the other problem is coming and that such tax will be placed on these creameries for advertising."

Motion was carried to accept the report and adopt the committee's recommendations.

DAIRY FARM SCORE CARD

ERNEST KELLY¹

Dairy Division, Washington, D. C.

Mr. President and Gentlemen: I want to appear before you in a dual rôle this afternoon to say a few words for the committee and a few in my own behalf. As to the committee report we have none to make at the present time. I was notified within the last ten days that I have been appointed chairman of the committee, and there has not been time since that for us to get together and do any work. Three of the committee were on the train together last night, and in talking together it was decided that it might be well for the committee to outline the original purposes of the dairy score card so that we might not lose sight of just what we were working for.

The dairy score card was outlined originally and intended to be used as a guide in bettering general conditions on the dairy farm. It was not formulated, and has never been used by those who have known its true purpose, as an index to the bacteria count of milk produced on a farm, in individual cases, and it cannot be so used.

I would like to tell you in a few words what we have been doing in the Department along these lines within the past year. There seems to have been two important criticisms in the past of the dairy farm score card, both of them, I believe, founded on misapprehensions; but the two most important criticisms have been first, that the dairy farm score card does not indicate the bacteria count of the milk produced on that farm. That is one that is surely founded on a misapprehension, because the score card was never intended to do that. The other criticism has been that the dairy farm score card used in inspection work has worked an injustice in a great many cases. That is really a

¹ Chairman of committee.

repetition of the first objection. Where it has been used as a sole guide or index to the quality of the milk, it sometimes has worked an injustice because the farm may produce good milk, and still have a low score. Personally, I believe that the unjust talk about the dairy farm score card is considerably exaggerated. I have had experience in most of the states touching some thousands of farms, and while there have been quite a number of cases, where there has been gross injustice, these cases have been of very small proportion when you take into consideration the whole number of farms which have been subjected to inspection. And very largely these injustices have been the result of faults in the inspectors themselves, rather than of faulty methods.

In order to answer the objections that have been made to the score card, a number of us in the dairy division began about a year ago in a series of conferences to see what could be done to formulate a new card, or change the score card in order that the objections might be overcome. Now, that card was formulated and has been on trial all this summer. We have scored several hundred dairies with this new form of card, and have taken bacteria counts in connection with them. I haven't said anything about this before because I want to be pretty sure of our card before we make any suggestions, but I am dealing with this card now as a serious suggestion, and to tell you that we have been using it; but we want to be sure of our data before we say anything, and so far we haven't had time to compare the results.

I have divided the score card into four sections. This may or may not be right, and we would be glad to have the help or assistance that any of the members of this Association can give us in making that right if it is not right. The first two sections are factors which affect the milk from a sanitary standpoint, and the last two sections are factors of more remote significance.

Now, personally, I do not feel, and I do not believe that any member of the score card committee feels that the bacteria count alone is the sole index of the desirability of market milk. There are a number of factors which are not in our present methods of laboratory control shown by the bacteria count, such

as the health of the cattle, the health of the employees, and a number of other things. We have separated these into one section and there we have health factors or specific disease factors such as health of employes, health of cattle, purity of water supply on the farm, and the disposal of excreta on the farm,—the main things which seem to have given the greatest trouble and have been the source of greatest danger.

Our second section is "major factors affecting bacteria count" and in this section we have selected those things which experiments up to the present time have indicated as most important as regards the bacteria count of the milk. We have selected these factors and weighed them according to the weights given them by the various experimenters, so that if that one section were used alone it should be an index of the bacteria count of the milk. Whether or not such a section to measure the bacteria count of the milk will be successful I cannot say.

The bacteria count must be made immediately after the time of production in order to have the score card workable. When the counts are made at the time of production there seem to be some very practical results; but I believe that will require considerable further work to show whether or not that section, or some other sort of score card can be gotten out that will prove a true index of the bacterial quality of the milk when produced because of certain results.

The other side of the card is divided into two sections which deal with economic aids to sanitation. For years we have been urging the dairy inspectors to work for more sanitary conditions on the farm, and to help also in the economic production of the milk. And this other side of the card is designed especially to help them along that line.

This side is divided into two sections, one general cleanliness and decency from equipment standpoint, and the other regarding methods, which, perhaps, may have only limited effect on the bacteria count of the milk.

The first section deals with the construction of the dairy so that it is easily cleaned; the location of the milk house so that it is convenient; the location of the water supply as to convenience;

and numerous other things which have to do with the convenience and economic conditions.

Now, as I have said, these are only tentative suggestions and we have offered them and want your criticisms. The committee has not gone over the data yet and was not ready to make any report at all, but I hope that this Committee will be able to work out something which will answer the criticisms which have been made, and take care of the score card needs of the future.

DISCUSSION

President Stocking said: "Might I suggest that you take the suggestions of this one now and be working on a score card from the different angles. It might be well to call on Dr. Harding to make his report, and we can discuss the two together.

(Dr. Harding then read his report which was printed in full in the Journal of Dairy Science, vol. i, no. 3.)

Discussion of both reports continued:

President Stocking said: "I intended to make a statement or explanation before Mr. Kelly addressed you. As members of the Association know, Mr. Lane who has come pretty close to being the father of sanitary milk grading of our Association, has been chairman of that committee since it has been on the list of committees of this Association; and it was my intention that he should continue as chairman of that committee; but, at his own urgent request that he be relieved of the chairmanship at this time, it was done, and Mr. Kelly was put on, and Mr. Kelly has not had time to make any report—I mean any other than a verbal report. Now, both of these reports are before you for discussion."

Professor Lane said: "In all fairness to Mr. Kelly, it should be stated that, while I was chairman of the two committees, our Department was making some investigation along the score card matter, and it was thought proper that a dairyman should be a member of that committee, but you see, Mr. Kelly was made commissioner before the investigation was over."

President Stocking said: "Some of you may have heard that Mr. Lane has recently received a higher position with the com-

pany with which he is connected, and as usual when a man is put in a new position, he wants to get out and work as hard as possible."

Prof. R. S. Breed made the following comments: "I would like to offer some comments on what Mr. Kelly has said. I do not think it can be too often repeated that the original purpose of the dairy score card was to measure the sanitary conditions, and as an index to the milk quality, and we in New York State have had it used in that way. I do not know under what classification our New York State milk is graded; but the rule in New York State generally covers quite a number of states, and we have issued through the state board of health a fixed state sanitary code. In that code the grade of milk is that which we get on the farm under a dairy score card—that is the sole index of the milk quality—that is the dairy score card, but that includes a very large bulk of the milk that is sold to the consuming communities of the state. The dairy score is used in that way.

"If I should offer any criticism at all in regard to the outlined score card which has been described it would be, perhaps, that in particular no part of it would seem to offer, or rather attempt to modify this score card—this dairy score card to be an index of the milk quality. Now, we have—we should have—a score card which does measure the dairy conditions on the farm; if it does not do that it would be of no use as an index of the quality of the milk. If you use it as an index of the conditions on the farm, it would be a pretty good index of the quality of the milk."

Prof. R. M. Washburn continued the discussion: "Since the old score card has been summed up so frequently, would it not be wise to go over the earlier situation, if possible, and get on a newer basis in which the score card shall indicate more closely the quality of the milk produced? Furthermore, in using the score card, it is only an indication of the quality produced, whether used for table, cooking or what purpose. When it is analyzed it does indicate that it is going along in the line indicated in the various milk ordinances, and that the quality is kept up all the time, it would seem that that would universally meet the situation."

Professor Kelly said: "I would like to call attention to one or two points before the discussion closes. Dr. Breed has pointed to a few of them. There is this consideration to be added, and I would like to have you think about it. There are throughout the country a great many small towns where the health officers receive an annual salary of from \$40 to \$200 a year for the control of all classes of sanitation that may arise in the town. They have no bacteriological laboratory and have no access to any. There is a question here—what can be done for milk control? In many of these towns they use some system of farm inspection and that is where the use of the score card comes in. In many of these little communities, the bacteria count is almost impossible under present conditions, and the score card has been used in a great many places for classifying the dairies because it was the only available means of inspection and classification.

"Dr. Harding had his report so full as to the amount and quality of the milk that it would not become us very well to go into that any further than to call attention to the fact that the quality of the milk, in my opinion, does not at all mean the bacteria count alone. We have special disease factors and other factors which must be considered in rating the quality of the milk."

Prof. J. H. Frandsen said: "I am very much interested in this report and realize that the committee have a tremendous task before them. I do not wish to appear to criticise their report. However, referring to the classification of milk as given by Dr. Harding,² this indicates but little difference between 'table' and 'special' milk.

"It seems to me that the term 'special milk' should indicate something much better than the other grades and I would suggest for your consideration, that, under the term healthfulness the clause be changed to read as follows: 'Medical supervision of health of men and animals whether milk is pastuerized or unpasteurized.'

"This would put 'special milk' distinctly in a class by itself."

² See classification of milk in "What is Meant by Quality of Milk." P. 212, vol. 1, no. 3. Journal of Dairy Science.

Dr. Harding said: "The statement regarding pasteurization is a question of diplomacy. There are several elements in the discussion which led to the outline taking this form. The difference between special and table milk seems simple but may offer some problems. 'Special' milk is so worded as to provide for certified milk when such exists. It also provides for any carefully inspected milk which is designed to be consumed unpasteurized.

"Differences are indicated in the table on page 13 between the special and table milk; also in the matter of keeping qualities. Other things being satisfactory, as they should be in both cases, you would find the long keeping quality of the milk in the special grade.

"As to the question of safety—they are supposed to be equally safe. The three grades should be the safe milk, and I personally feel that the pasteurized is safer than raw milk of the special grade. But in saying that, I am not speaking as a representative of the Committee, or any one in particular; I am speaking for myself individually. It is hard to get a committee to agree in all particulars, to see the same things alike; but I think that in all these three classes of milk you have a fairly safe milk as the word safe is ordinarily used. I do not think that they vary much on that point. I do not know whether we have the same idea of safety. I use this illustration in expressing the opinion to my classes. I explain to them how many instances there are on record of diseases being transmitted through milk, and the factors and characteristics of the various epidemics, and then I explain to them the probability of their contracting one of those diseases when they drink a glass of milk purchased in the open market; the mathematical probability of their contracting disease from the next glass of milk is about equal to the probability of their being killed on their next railroad journey; and still with that small probability of disease in the ordinary milk supply, I still think it is incumbent upon us to pasteurize milk in order to still further reduce danger from that source."

Professor Rasmussen said: "As has been said in this discussion it is very likely that just as much milk that is labelled cooking milk may be used on the table. In other words, if the

milk is only labelled as cooking milk, any one can buy the milk and use it on the table. Is that correct?"

Dr. Harding: "I think it is the American privilege to buy in the market and use where one chooses to use it."

Professor Rasmussen: "Yes, take the table milk and use the table milk for table purposes, and avoid the other kind. Yet if we knew this cooking milk was not considered fit for table use—but that is not the understanding. I just wondered whether some other term would be better to express it as a grade below the milk to be used as a table milk—it doesn't make any difference, or so much difference to some what they buy if it should be safe to use."

Dr. Harding: "There is a distinct difference in the two grades of milk which I believe the public will recognize and use in connection with the products. Table milk will have many advantages particularly more keeping quality, and therefore, be accepted for table use. In many instances, cooking milk will be a milk which has more dirt in it and is not so desirable. I think that we must get away from the idea, gentlemen, that the one thing which makes milk undesirable is danger to health. The red flag has been floated before the public too long—the milk danger flag. As a matter of fact, milk is both the most economic and substantial food that we can take. I think all of this milk can be rendered safe from the standpoint of the consumer's health; but we cannot take dirty milk and render it clean. We have recognized the fact that we must provide for cleanliness, and we can not take milk which is very nearly sour and make it fresh and sweet again; nor can we take 3 per cent milk and make it 5 per cent milk."

Prof. Anderson: "Would you consider this plan of grading milk as satisfactory for embodying in milk ordinances?"

Dr. Harding: "I should say that it was not at present because ordinances would call for tests for keeping quality which is not yet provided in this outline. This is not a finished thing ready to be made into an ordinance. It is submitted in this unfinished condition so that it can be open to criticism before being finished."

The Member: "Do you think it is safe to sell in a state, or

have milk to sell of the third grade—third grade milk, not having been subjected to pasteurization?”

Dr. Harding: “Our contention is that cooking milk should be made safe in regard to public health by boiling.”

The Member: “I mean is it a violation at the place of sale or not? I mean if is it ‘boiled’ at the place of sale or not?”

Dr. Harding: “It should be boiled before being offered for sale. I have been joked a great deal by that ‘boiling’—and as I suggested it I should take the blame. There is this to be said in favor of this plan of grading the milk—requiring that milk to be boiled—it would prevent some misunderstanding as happens when oleomargarine is colored—it would be a distinctive mark on the grade, and that same public would recognize it as a third grade milk.”

Prof. C. W. Larson: “In reading over the classes and grades of milk as outlined, I have been unable to see how real quality is defined. It appears to me that the grades are simply instructions of how to treat any milk, regardless of its quality, in order to sell it under a particular grade. If a distributor were to secure the most unclean milk from even diseased, emaciated cows, clarify it so as to remove all visible dirt, and pasteurize it, then when he got through with this treatment, he could label it two or three per cent fat according to its composition and sell it as ‘table milk.’ It is table milk that would be used generally for direct consumption by children as well as others. Am I not correct in this conclusion?”

A Member: “I would like to ask if there is at present any educational work, or paper, which has shown any extensive work in the third grade milk?”

Dr. Harding: “Any system of classification which does not provide a place for all the milk, is not a complete classification. What are you going to do with the milk that does not come into the ‘table grade?’ There must be some place to put this in your classification.”

Motion was made to receive the two reports and place them on file which motion was carried.

STATISTICS OF PRODUCTION AND MARKETING OF DAIRY PRODUCTS

ROY C. POTTS¹

Washington, D. C.

Within the limited time which your committee has had in which to give consideration to the subject of statistics of production and marketing of dairy products it has been impossible for the committee to formulate and conduct a definite study of the subject. Its report, therefore, cannot represent all that might be said on the subject. It is the purpose of this report to present a review of rather meagre observations which have been made, and to bring to the attention of the Association the need of a more systematized method of obtaining, compiling, and using statistics relating to the production and marketing of dairy products as they may be used in the more intelligent study of dairy conditions as they apply both to the production and marketing of dairy products.

An effort was made by the committee to assemble such statistics as are now available from various sources including those of municipal, state, and federal departments of government. Several singular and important facts were noted in reviewing the replies received from the parties addressed, and also the statistics obtained from the available sources. (1) Very few authorities endeavored to obtain any statistics at all. (2) Those who made an effort to obtain statistics admitted that they were incomplete and possibly inaccurate. (3) Such statistics as were compiled were not comparable because they were not secured in the same way or for the same purpose. (4) Most of the authorities agreed to the importance of securing more complete and authoritative statistics and to the use of uniform statistical blanks in securing dairy statistics. (5) Some authorities stated

¹ Chairman of committee.

that they were entirely without authority to obtain statistics on dairy products, and legislative action would be necessary before they could undertake such work. These facts indicate in general the conditions which exist, and it is obvious that to secure the coöperation and uniform action on the part of those who compile dairy statistics, in assembling all statistics in such a way that they would be comparable is a considerable task.

Before endeavoring to secure such action, it came to the attention of the committee that the Bureau of Markets, of the United States Department of Agriculture, in obtaining dairy products reports from the dairy manufacturing concerns of the country, might be able to compile the essential dairy statistics in regard to the production and marketing of dairy products were it given the coöperation and assistance of all other agencies engaged in compiling such statistics. The work undertaken by this Bureau with reference to the statistics on dairy products is considered by the committee to be of sufficient importance to warrant its consideration in the committee's report. A brief statement will indicate the method of procedure of the Bureau and its plan of obtaining, compiling, and issuing dairy statistics.

The committee is informed that the Bureau of Markets has secured from various sources the names and addresses of near twenty thousand dairy manufacturing and milk distributing concerns in the United States. A card index file list of these firms has been prepared in alphabetical order by states, cities and firms within each city. To these firms monthly statistical form blanks are sent as per the blank form on page 411.

It will be noted that the blank includes the major manufactured milk products, carrying the same under twenty-seven items, and in addition to this blank a separate blank is used to secure statistics of oleomargarine products, both colored and uncolored, making two other additional items. Comment upon this schedule seems unnecessary, other than to say that it appears to be very complete and should enable the Bureau when filled out regularly each month by each dairy manufacturing concern in the United States to compile and issue accurate and authentic dairy statistics.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF MARKETS
Washington, D. C.
WAR EMERGENCY DAIRY PRODUCTS REPORT

This schedule must be returned to the Bureau of Markets, Washington, D. C., by October 3, 1917, and must be filled out in accordance with the instructions on the reverse side and in the accompanying letter.

*	PRODUCTS	MONTH OF SEPTEMBER		*
		1916	1917	
6001	Creamery butter.....Lbs.			Ent'd
6002	Process (renovated) butter.....Lbs.			1917
	American cheese:			
6003	"Whole milk".....Lbs.			Check
6004	"Part skim".....Lbs.			1917
6005	"Full skim".....Lbs.			
6006	Swiss cheese.....Lbs.			Ent'd
6007	Brick and Munster cheese.....Lbs.			1916
6008	Limburger cheese.....Lbs.			
6009	Cottage, pot, bakers, cream, and Neufchatel cheese curd.....Lbs.			Check 1916
6010	All other varieties of cheese.....Lbs.			Punch
6011	Casein (dried).....Lbs.			1917
	Condensed and evaporated milk:			
	Unskimmed (case goods)—			
6012	Sweetened.....Lbs.			Check
6013	Unsweetened.....Lbs.			1917
	Skimmed (case goods)—			
6014	Sweetened.....Lbs.			O. K.
6015	Unsweetened.....Lbs.			
	Unskimmed (bulk goods)—			Punch
6016	Sweetened.....Lbs.			1916
6017	Unsweetened.....Lbs.			Check
	Skimmed (bulk goods)—			1916
6018	Sweetened.....Lbs.			
6019	Unsweetened.....Lbs.			
6020	Sterilized milk.....Lbs.			O. K.
6021	Condensed buttermilk.....Lbs.			
6022	Powdered buttermilk.....Lbs.			
6023	Powdered whole milk.....Lbs.			
6024	Powdered skimmed milk.....Lbs.			
6025	Malted milk.....Lbs.			
6026	Milk sugar.....Lbs.			
6027	Ice cream of all kinds.....Gals.			

* These columns are to be reserved for use by the Bureau of Markets.

I hereby certify that the information given in the foregoing schedule, and the accompanying papers, if any, is true and complete to the best of my knowledge and belief.

Date....., Name of concern.....

Address: Street....., City....., State.....

Signature of authorized person.....

Position or title.....

The committee is advised that it is the intention of the Bureau to coöperate with the dairy departments of agricultural colleges, also the dairy and food departments of the various states, by furnishing the college and food department in each state with a card index file of the firms within the respective state, which list corresponds with the file kept by the Bureau. With the coöperation and assistance of the colleges and dairy and food departments, the mailing list of the Bureau, also of the college and food departments, can be kept complete and up to date. The committee heartily recommends to the members of the American Dairy Science Association, who are connected with the dairy departments of the agricultural colleges or the dairy and food departments of the various states, that they render every assistance to the Bureau of Markets in its work.

The committee has been further advised that the Bureau of Markets will compile and issue monthly for the whole United States and separately for each state separate reports for each of the items included on the foregoing schedule or dairy products report form. Such reports issued by the Bureau of Markets will, for all practical purposes in the various states and for the United States, be authentic and accurate as to the amount of the various dairy products manufactured.

As a separate and distinct undertaking apart from the production reports, the Bureau of Markets is, and has for some time, been compiling monthly reports of the amount of creamery butter, packing stock butter, and cheese in storage. These reports are compiled in a very similar way to the production reports which have been previously described. A copy of the form blank or schedule used by the Bureau in securing the reports from the various cold storage firms, also copies of the summarized reports of the holdings of creamery butter, packing stock butter, and cheese in storage, as issued by the Bureau for the month of September, 1917, are submitted herewith.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF MARKETS
Washington, D. C.

REPORT OF PRODUCTION OF..... FOR MONTH OF..... 191
WITH COMPARISONS FOR CORRESPONDING MONTH THE PREVIOUS YEAR

STATE	TOTAL NUMBER OF CONCERNS REPORT- ING	TOTAL QUANTITY MANUFAC- TURED	COMPARISON			
			Number of concerns reporting	Septem- ber 1916	Septem- ber 1917	Increase or decrease (per cent)
Alabama.....						
Arizona.....						
Arkansas.....						
California.....						
Colorado.....						
Connecticut.....						
Delaware.....						
District of Columbia.....						
Florida.....						
Georgia.....						
Idaho.....						
Illinois.....						
Indiana.....						
Iowa.....						
Kansas.....						
Kentucky.....						
Louisiana.....						
Maine.....						
Maryland.....						
Massachusetts.....						
Michigan.....						
Minnesota.....						
Mississippi.....						
Missouri.....						
Montana.....						
Nebraska.....						
Nevada.....						
New Hampshire.....						
New Jersey.....						
New Mexico.....						
New York.....						
North Carolina.....						
North Dakota.....						
Ohio.....						
Oklahoma.....						
Oregon.....						
Pennsylvania.....						
Rhode Island.....						
South Carolina.....						
South Dakota.....						
Tennessee.....						
Texas.....						
Utah.....						
Vermont.....						
Virginia.....						
Washington.....						
West Virginia.....						
Wisconsin.....						
Wyoming.....						
Total.....						

THIS SCHEDULE RETURNABLE NOT LATER THAN OCTOBER 4, 1917
REPORT ONLY GOODS ON HAND IN YOUR OWN WAREHOUSE

CODE*	COMMODITIES	BASIS 1916	OCTOBER 1, 1916	OCTOBER 1, 1917	*
2001	Butter (Creamery).....(Pounds).....				Entered
2002	Cheese (American)..... "				1917
2003	Eggs.....(Cases).....				Check
2004	Frozen Eggs.....(Pounds).....				1917
2005	Packing Stock Butter.. "				Entered
3001	Frozen Beef..... "				1916
3002	Cured Beef..... "				Check
3003	Frozen Pork..... "				1916
3004	Dry Salt Pork..... "				Punch
3005	Sweet Pickled Pork.... "				1917
3006	Lard..... "				Check
3007	Lamb and Mutton Frozen. "				1917
4001	Broilers..... "				Punch
4002	Roasters..... "				1916
4003	Fowls..... "				Check
4004	Turkeys..... "				1916
4005	Miscellaneous Poultry.. "				O. K.

* These columns for use in this Bureau only.

I hereby certify that the answers given on the foregoing schedule are true and complete to the best of my knowledge and belief.

.....
(Name of concern)

.....
(Signature of authorized person.)

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF MARKETS
Washington, D. C.

October 11, 1917

REPORT OF COLD STORAGE HOLDINGS OF CREAMERY BUTTER,
OCTOBER 1, 1917

Reports from 380 cold storages show that their rooms contain 104,293,375 pounds of CREAMERY BUTTER while on September 1, 354 storages reported 100,-839,277 pounds. The 332 storages that reported holdings on October 1, of this year and last show a present stock of 97,456,876 pounds as compared with 100,-521,573 pounds last year, a decrease of 3,064,697 pounds or 3.0 per cent. The

reports show that during September, the September 1 holdings increased 0.1 per cent, while our last report showed that during August, the August 1 holdings increased 14.4 per cent. Last year the decrease during September was 7.8 per cent and in August the increase was 3.3 per cent. A summary of this report was released by wire on October 11. As a number of firms have not responded to our inquiries, this report does not include all holdings. Upon request any or all of the information contained in the cold storage reports will be telegraphed immediately upon its release. These reports are free, except for the telegrams, which are sent charges collect.

SECTION	TOTAL HOLDINGS OCTOBER 1, 1917		COMPARISON OF HOLDINGS			
	Number of storages reporting	Pounds	Number of storages reporting	October 1, 1916, pounds	October 1, 1917, pounds	Increase or decrease (per cent)
New England.....	30	24,670,258	27	25,044,351	22,802,188	- 9.0
Middle Atlantic.....	88	31,023,869	82	30,883,321	30,777,908	- 0.3
South Atlantic.....	32	1,653,724	24	1,475,272	1,630,806	+10.5
N. Central (E).....	64	28,461,982	54	27,359,933	24,233,900	- 11.4
N. Central (W).....	59	11,863,653	56	8,915,165	11,571,681	+29.7
South Central.....	41	1,581,113	36	1,268,628	1,576,298	+24.3
Western (N).....	32	1,807,300	26	1,930,854	1,649,556	-14.6
Western (S).....	34	3,231,476	27	3,644,049	3,214,539	-11.8
Total.....	380	104,293,375	332	100,521,573	97,456,876	- 3.0

	NUMBER OF STORAGES REPORT- ING	POUNDS	COMPARI- SON ON PERCENT- AGE BASIS	INCREASE OR DECREASE (POUNDS)
Comparison of holdings:				
on September 1, 1917.....	320	98,672,970	100.0	
and October 1, 1917.....	320	98,749,922	100.1	+76,952
Comparison of holdings:				
on September 1, 1916.....	251	105,285,506	100.0	
and October 1, 1916.....	251	97,092,876	92.2	-8,192,630
Comparison of holdings:				
on August 1, 1917.....	294	86,235,920	100.0	
and September 1, 1917.....	294	98,683,757	114.4	+12,447,837
Comparison of holdings:				
on August 1, 1916.....	233	101,606,527	100.0	
and September 1, 1916.....	233	104,930,786	103.3	+3,344,259

NEW ENGLAND: Me., N. H., Vt., Mass., R. I., Conn. MIDDLE ATLANTIC. N. Y., N. J., Pa. SOUTH ATLANTIC: Del., Md., D. C., Va., W. Va., N. C., S. C., Ga., Fla. NORTH CENTRAL (East of Miss. River) Ohio, Ind., Ill., Mich., Wis., (West of Miss. River) Minn., Iowa, Mo., N. D., S. D., Nebr., Kans. SOUTH CENTRAL: Ky., Tenn., Ala., Miss., La., Tex., Okla. Ark. WESTERN: (North) Mont., Wyo., Idaho, Wash., Ore. (South) Colo., N. Mex., Ariz., Utah, Nev. Calif.

CHARLES J. BRAND,
Chief.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF MARKETS
Washington, D. C.

October 11, 1917

REPORT OF COLD STORAGE HOLDINGS OF PACKING STOCK BUTTER,
OCTOBER 1, 1917

Reports from 107 cold storages show that their rooms contain 2,493,174 pounds of PACKING STOCK BUTTER while on September 1, 83 storages reported 2,531,215 pounds. The 81 storages that reported holdings on October 1, of this year and last show a present stock of 1,901,354 pounds as compared with 3,332,810 pounds last year, a decrease of 1,431,456 pounds or 43.0 per cent. The reports show that during September, the September 1 holdings decreased 29.3 per cent. Last year the decrease during September was 6.3 per cent. A summary of this report was released by wire on October 11. As a number of firms have not responded to our inquiries, this report does not include all holdings. Upon request any or all of the information contained in the cold storage reports will be telegraphed immediately upon its release. These reports are free, except for the telegrams, which are sent charges collect.

SECTION	TOTAL HOLDINGS OCTOBER, 1917		COMPARISON OF HOLDINGS			
	Number of storages reporting	Pounds	Number of storages reporting	October 1, 1916, pounds	October 1, 1917, pounds	Increase or decrease (per cent)
New England.....	2	427	1	180	227	+ 26.1
Middle Atlantic.....	10	187,153	7	344,637	105,715	- 69.3
South Atlantic.....	8	83,681	7	22,549	50,999	+126.2
N. Central (E).....	30	1,244,253	22	1,308,770	1,072,193	- 18.1
N. Central (W).....	38	720,499	31	1,491,393	441,874	- 70.4
South Central.....	8	67,445	6	7,162	50,148	+600.2
Western (N).....	6	54,888	3	6,584	46,472	+605.8
Western (S).....	5	134,828	4	151,535	133,726	- 11.8
Total.....	107	2,493,174	81	3,332,810	1,901,354	- 43.0

PRODUCTION AND MARKETING OF DAIRY PRODUCTS 417

	NUMBER OF STORAGES REPORT- ING	POUNDS	COMPAR- ISON ON PERCENT- AGE BASIS	INCREASE OR DECREASE POUNDS
Comparison of holdings:				
on September 1, 1917.....	72	2,295,808	100.0	
and October 1, 1917.....	72	1,622,720	70.7	-673,088
Comparison of holdings:				
on September 1, 1916.....	45	3,278,785	100.0	
and October 1, 1916.....	45	3,070,881	93.7	-207,904

NEW ENGLAND: Me., N. H., Vt., Mass., R. I., Conn. MIDDLE ATLANTIC: N. Y., N. J., Pa. SOUTH ATLANTIC: Del., Md., D. C., Va., W. Va., N. C., S. C., Ga., Fla. NORTH CENTRAL: (East of Miss. River) Ohio, Ind., Ill., Mich., Wis., (West of Miss. River) Minn., Iowa, Mo., N. D., S. D., Nebr., Kans. SOUTH CENTRAL: Ky., Tenn., Ala., Miss., La., Tex., Okla., Ark. WESTERN: (North) Mont., Wyo., Idaho, Wash., Ore. (South) Colo., N. Mex., Ariz., Utah, Nev., Calif.

CHARLES J. BRAND.
CHIEF.

UNITED STATES DEPARTMENT OF AGRICULTURE BUREAU OF MARKETS Washington, D. C.

October 11, 1917

REPORT OF COLD STORAGE HOLDINGS OF AMERICAN CHEESE. OCTOBER 1, 1917

Reports from 438 cold storages show that their rooms contain 84,328,964 pounds of AMERICAN CHEESE while on September 1, 393 storages reported 81,974,731 pounds. The 373 storages that reported holdings on October 1 of this year and last show a present stock of 76,498,987 pounds as compared with 49,579,142 pounds last year, an increase of 26,919,795 pounds or 54.3 per cent. The reports show that during September, the September 1 holdings increased 0.4 per cent, while our last report showed that during August, the August 1 holdings increased 27.6 per cent. Last year the decrease during September was 5.3 per cent and the increase during August was 14.6 per cent. A summary of this report was released by wire on October 11. As a few storages have not responded to our inquiries, this report does not include all holdings. Upon request, any or all of the information contained in the cold storage reports will be telegraphed immediately upon its release. These reports are free, except for the telegrams, which are sent charges collect.

SECTION	TOTAL HOLDINGS OCTOBER 1, 1917		COMPARISON OF HOLDINGS			
	Number of storages reporting	Pounds	Number of storages reporting	October 1, 1916, pounds	October 1, 1917, pounds	Increase or decrease (per cent)
New England.....	26	7,180,684	20	5,593,677	6,844,023	+ 22.4
Middle Atlantic.....	105	33,093,678	93	20,441,479	31,835,286	+ 55.7
South Atlantic.....	40	3,000,741	31	2,028,442	2,178,270	+ 7.4
North Central (E)...	94	28,028,111	80	13,034,220	23,053,354	+ 76.9
North Central (W)...	58	3,806,751	56	2,580,077	3,804,751	+ 47.5
South Central.....	50	1,855,216	39	718,126	1,663,750	+131.7
Western (N).....	29	1,165,397	24	845,245	1,066,521	+ 26.2
Western (S).....	36	6,198,386	30	4,337,876	6,052,982	+ 39.5
Total.....	438	84,328,964	373	49,579,142	76,498,937	+ 54.3

	NUMBER OF STORAGES REPORT- ING	POUNDS	COMPARI- SON ON PERCENT- AGE BASIS	INCREASE OR DECREASE (POUNDS)
Comparison of holdings: on September 1, 1917.....	360	81,280,743	100.0	
and October 1, 1917.....	360	81,638,837	100.4	+358,094
Comparison of holdings: on September 1, 1916.....	273	46,776,039	100.0	
and October 1, 1916.....	273	44,308,627	94.7	-2,467,412
Comparison of holdings: on August 1, 1917.....	323	58,218,536	100.0	
and September 1, 1917.....	323	74,300,651	127.6	+16,082,115
Comparison of holdings: on August 1, 1916.....	198	29,421,708	100.0	
and September 1, 1916.....	198	33,545,179	114.0	+4,123,471

NEW ENGLAND: Me., N. H., Vt., Mass., R. I., Conn. MIDDLE ATLANTIC: N. Y., N. J., Pa. SOUTH ATLANTIC: Del., Md., D. C., Va., W. Va., N. C., S. C., Ga., Fla. NORTH CENTRAL: (East of Miss. River) Ohio, Ind., Ill., Mich., Wis., (West of Miss. River): Minn., Iowa, Mo., N. D., S. D., Nebr., Kans. SOUTH CENTRAL: Ky., Tenn., Ala., Miss., La., Tex., Okla., Ark. WESTERN: (North) Mont., Wyo., Idaho, Wash., Ore. (South) Colo., N. Mex., Ariz., Utah, Nev., Calif.

CHARLES J. BRAND,
Chief.

It would seem unnecessary for the committee to comment to any considerable extent upon this phase of the Bureau's work in compiling storage statistics on dairy products. However, the committee is informed that, supplementary to the production reports and cold storage reports, the proposed activities of the Bureau in connection with the establishing of a market news service on dairy products will include the compiling and issuing of statistics in regard to the receipts of butter on the larger and more important wholesale butter markets, at which branch offices of the Bureau are to be established, also of the amount of butter carried from day to day in the coolers of the wholesale market receivers, the in-go and out-go of butter from storage, the transfer of ownership of butter in storage, and daily statistics in regard to exports and imports and shipments to out of town, nearby, and distant jobbing trade.

With the undertaking of such comprehensive and useful statistical work by the Bureau of Markets relating to the production and marketing of dairy products, the committee cannot help but feel that the members of the American Dairy Science Association should be most appreciative of the Bureau's work and endeavor to make every practical use that is possible of the statistical reports issued by the Bureau relating to the production and marketing of dairy products. The committee further feels that on account of the comprehensiveness of the Bureau's activities that there is comparatively little which remains for the committee to do in the matter of suggesting improvements in the compilation of dairy statistics. It does feel, however, if it is the desire of the Association, that it may be able to continue its work to the end that suggestions may be offered in a future report dealing with the interpretation, application, and practical use which may be made by the dairy industry of the statistics compiled and issued by the Bureau of Markets, of the United States Department of Agriculture.

It was moved and carried that the report be accepted and that the American Dairy Science Association approve the work of this committee.

EVENING SESSION

Meeting called to order by President Stocking, who said:

Gentlemen, I think we should feel rejoiced tonight at the size of the gathering that we have here. I do not know that I have missed one of these annual banquets for the last seven or eight years at least, and this is by far the largest that I have seen. It is a splendid thing for us to get together each year, and throw off the restraint when we have a chance, and visit informally.

Tonight there is no program or rather we will vary the program for the time we will spend here, but there are a few men connected with other pursuits that we want to hear from, because we are interested in the work that they are doing, and for which they are responsible. I am sure that every member of the Association would like to hear from the man who has charge of the dairy judging contest and I will predicate by asking Mr. Rabild to give us his report on the contest.

STUDENTS' NATIONAL CONTEST IN JUDGING DAIRY
CATTLE. NATIONAL DAIRY SHOW,
COLUMBUS, OHIO

HELMER RABILD¹

Dairy Division, Washington, D. C.

We realize that they have this year had to meet some very unusual obstacles and that it has meant real hard and earnest effort to manage to get the teams ready for the contest and have them here in actual competition. We appreciate these efforts and I told Mr. Skinner this morning that I think it is that kind of spirit which is going to carry us "over the top." Now just for a brief report of the contest.

The Ninth Annual Students' National Contest in Judging Dairy Cattle was held at the National Dairy Show at Columbus, Ohio, October 19, 1917. Thirteen State agricultural colleges were represented by teams, from Massachusetts to Missouri and from Virginia to South Dakota. Each team consisted of three students accompanied by the professor in dairy or animal husbandry who had coached the team. The students were required to judge eight classes of cattle, consisting of four bulls and four cows of each of the following breeds: Ayrshire, Guernsey, Holstein and Jersey. The official placing of the animals in the contest was made by a committee composed of the coaches of the various teams; namely, Professors Frank A. Hays, Delaware; Robert Wylie, Iowa; J. B. Fitch, Kansas; J. J. Hooper, Kentucky; R. H. Ruffner, Maryland; J. C. McNutt, Massachusetts; W. W. Swett, Missouri; B. H. Thompson, Nebraska; W. M. Regan, New Jersey; S. M. Salisbury, Ohio; E. L. Anthony, Pennsylvania; C. Larsen, South Dakota; and R. E. Hunt, Virginia.

The students were divided into four groups in such a way that

¹ Superintendent of contest.

no two students from the same college were in the same group. The students were required to rank each class of cattle in the order of their merit in conformation, and were then required to withdraw from the ring and write why they placed the animals in each class of cattle as they did. The final awards were made not only on the students' ability to place the cattle correctly, but also on their ability to state the reasons for such placing.

The students were competing for three \$400 scholarships and for numerous cups and trophies. The scholarships will be used for post-graduate work in dairy husbandry. One scholarship was offered by the Holstein-Friesian Association of America to the student who did the best work in judging Holsteins; another was given by the DeLaval Separator Company to the man who did the best work in judging all breeds; and a third was presented by the Associated Manufacturers' Company, manufacturers of the Iowa Dairy Separator, to the college whose team did the best work in judging all breeds.

SWEEPSTAKES TEAMS

The three teams winning highest honors or sweepstakes in the contest were as follows: I. University of Missouri. II. Iowa State College. III. University of Nebraska.

In addition to winning the Iowa Dairy Separator scholarship of \$400, the University of Missouri also won silver loving cups offered by the National Dairy Show and by the Hoard's Dairyman Publishing Company.

The Iowa State College won a silver loving cup offered by the J. B. Ford Company, manufacturers of the Wyandotte Dairyman's Cleaner and Cleanser, for having the second highest team in the contest.

SWEEPSTAKES MEN

The five highest men in judging all breeds were as follows: (1) M. R. Dunn, Missouri; (2) C. A. March, Iowa; (3) Otto Schaefer, Missouri; (4) E. B. Nelson, Iowa; (5) S. V. Layson, South Dakota.

The highest or sweepstakes man, Mr. M. R. Dunn, from

Missouri, won the \$400 DeLaval scholarship. Each of the above mentioned men was also awarded a gold medal by the National Dairy Show.

THE HOLSTEIN SCHOLARSHIP

The three highest men in judging Holsteins were as follows:
 (1) J. R. Shepherd, Nebraska; (2) M. R. Dunn, Missouri;
 (3) A. E. Miller, South Dakota.

Mr. J. R. Shepherd of the University of Nebraska winning the \$400 Holstein-Friesian scholarship.

THREE HIGHEST TEAMS IN EACH BREED

Ayrshire. (1) University of Missouri, (2) Delaware College
 (3) Iowa State College.

The University of Missouri won the silver loving cup offered by the Ayrshire Breeder's Association.

Guernsey. (1) Pennsylvania State College, (2) Iowa State College, (3) South Dakota State College.

The Pennsylvania State College won the silver loving cup offered by the American Guernsey Cattle Club.

Holstein. (1) University of Nebraska, (2) University of Missouri, (3) Iowa State College.

The University of Nebraska won the silver loving cup offered by the Holstein-Friesian Association of America.

Jersey. (1) University of Missouri, (2) Kentucky State University, (3) Maryland Agricultural College.

The University of Missouri won the silver loving cup offered by the American Jersey Cattle Club.

UNIVERSITIES AND COLLEGES PARTICIPATING

Delaware College,
 Iowa State College,
 Kansas State Agricultural College,
 Kentucky State University,
 Maryland Agricultural College,

Massachusetts Agricultural College,
University of Missouri,
University of Nebraska,
New Jersey College of Agriculture,
Ohio State University,
Pennsylvania State College,
South Dakota State College,
Virginia Agricultural and Mechanical College.

I presume, gentlemen, that you have had a good many reports this afternoon, and I shall not weary you with an extended report of the contest. I desire to say, however, and I am sure of speaking for the Dairy Show also, that we appreciate very much the spirit on the part of the colleges who got teams ready for this contest.

STUDENTS' DAIRY PRODUCTS JUDGING CONTEST

W. P. B. LOCKWOOD¹

Amherst, Massachusetts

The students' judging contest for dairy products was carried on under adverse conditions this year. As a matter of fact the committee did not think they were going to have a contest until along about the middle of August. Last year, if you remember, we had \$500 to offer as cash prizes, this was given to us by the Massachusetts Society for the Promotion of Agriculture, but they would not give us money for a contest held outside of Massachusetts, and the time was so short that we could not secure money from other sources. Therefore we were unable to offer money prizes this year.

There were three cups offered this year: The J. B. Ford Company offered a cup for the team scoring highest in judging market milk. This was won by the team from the South Dakota State College. The J. G. Cherry Company offered a cup for the team scoring highest in judging butter. This was won by the team from the South Dakota State College. The Hoard's Dairyman offered a cup for the team scoring highest in judging cheese, and this was won by the team from the University of Nebraska.

I wrote to members of the committee relative to changing the methods, etc., for conducting the contest, but received few answers.

Last year we put the work on the total scores of each sample. This year we graded every item and deducted differences from Judges score on the item, totalling the results for the sample, and the totals for all samples determined the placing.

Three teams were in the contest: South Dakota State College, the University of Nebraska and University of Ohio. I am sorry

¹ Superintendent of contest.

that we did not have more teams as I think Mr. Skinner feels we ought to have at least half as many as the stock judging contest. I want to say this, that it cost more money to run our contest than to run the cattle judging contest for what we apparently get out of it.

It would seem that the judging of dairy products deserves pretty nearly as good a place as the judging of cattle, and we can get it; but the attitude is not towards it, and we will have to create this attitude. The question came up whether or not we should spend enough money to conduct the contest as originally planned and pay for the judges. The cattle men have men to act as judges at their contests who do not cause extra expense. If we were to bring judges for the judging of dairy products it would mean one for each product, or three judges in all which means expenses for three men. Although the work warrants this, it does not make the appearance that is made when judging cattle.

If we had had time to build up incentives enough to get teams to come to the contest we would have had a larger number of teams and possibly the present objection to expense would not have been so strong. Judging was the real object of this contest. After all judging was done the judges met the instructors and contestants and went over all samples that had been previously judged. The placing of the samples of each product was examined by the instructors, students, and judges, then the judges criticized them telling why they were placed as they were. The sample that scored highest of each product, was discussed thoroughly in order that both instructors and contestants might carry away the judges' ideas of best quality products. This was very educational as each man gathered information which he took back with him to his work.

It seems to me that this is the thing which must be individually followed by each teacher, in getting these ideas fixed in our commercial courses, and when we find a high grade of butter score it, discuss it, and carry back to our institutions the ideas and standards that we will have to meet in our production.

Next year I hope we will have more cups for prizes, a first,

second, and third cup for teams. I believe manufacturers will put up a manufacturers' scholarship. Possibly a group of manufacturers, or interested men, may be persuaded to contribute a small amount each for its support. I have talked with one or two men regarding this and they felt this might be feasible and that it would be a start forward for us. I thank you.

ADDRESS¹

B. H. RAWL²

Washington, D. C.

If I mistake not this organization was created about ten or twelve years ago. I think it was at the home of Professor Decker that the suggestion of this organization was made—at one of the sessions of the graduate school of agriculture in 1906. I was not present at that time, but I was present a little later, at a little impromptu meeting. After talking a little while we began to take stock; then this organization was started. It was characterized then by the kind of men that we have here tonight and it has grown greatly in eleven years.

And that reminds me of what seems to me an essential consideration, that the organization has not grown just because it was easier for it to grow than to stand still. The members, then as now, were the educational leaders of the industry, and by the way, at that time a great many of the dairy departments of our agricultural colleges consisted of but one man. Today some of these institutions have a large number of men representing the dairy department. The separation of dairying into its various distinct branches has taken place so that this growth represents in a measure the importance and substantialness of the industry that we are engaged in furthering. Perhaps it is not amiss, therefore, at the present time, to look back over the progress along this line.

We are now passing through a most remarkable period. Our commercial system and our educational system, and in fact our whole lives, are surrounded by circumstances that none of us could have imagined a short time ago.

¹ Address delivered at the evening session of the American Dairy Science Association, Columbus, Ohio, October 22, 1917.

² Chief of United States Dairy Division.

Some of us have come to look upon the dairy industry as a fixed and fundamental part of the agriculture of the future of this Nation. As the agriculture is developed, as the national demands for intensive agriculture increase, we feel that dairying is going to be made an increasingly important factor. By helping that industry to meet the demands that are to be placed upon it, this organization and other organizations of leaders, teachers, and investigators of the world can render a great service to mankind. I believe that in the next ten years we shall see a growth of the dairy industry far greater than we have had in the past ten and we must all do our share to help in the development.

New problems of dairying confront us now. Almost daily the food administration tells of the importance of maintaining the best agricultural situation in order to insure the food supply. We are informed that the food of the world and particularly the food supply of this Nation, will be an enormous, if not deciding factor, in this great world war. If that is true it is the duty of every American to do his share. I suppose that you have to face a situation similar to that with which we are confronted, in which the demands come from every source for something to be done along this line, that or the other; but frequently the demands are not associated with or accompanied with workable suggestions.

It seems that one of the first essentials, one of the steps of greatest importance, is that we should undertake to make the most complete utilization possible of the supplies which the dairy industry now affords. Is it not possible for you as representatives from most of the States to obtain a more complete utilization of dairy products and by-products? About 50 per cent of the milk of the nation is used for making butter. From this branch of the industry there are left enormous quantities of by-products, such as skim milk and buttermilk. While these are usually not wasted, they are not being used to the best advantage for human food. The Dairy Division did some work this summer in helping creameries, milk plants, and farmers to make better use of the dairy by-products. I wish to express

here our great appreciation of the coöperation of the various institutions throughout the country in assisting us along some of these lines. In the work to utilize fully the by-products by creameries and milk plants, I had a statement a short time ago regarding the results.

In all, during the summer, 10 men were employed on the work in New York, Michigan, Vermont, Wisconsin, Minnesota, Ohio, Maryland, West Virginia, Iowa and Pennsylvania. Seven hundred and twenty-six creameries and milk plants were visited, 58 of which were interested in making cottage cheese, 7 in condensing skim milk, and 2 in utilizing whey for human food. During the summer as a result of this work, 2,015,100 pounds of cottage cheese were made; 7,360,100 pounds of skim milk was condensed, and 560,000 pounds of whey made into primost and albumin cheese. Figuring on the food value of the various products, it has been estimated that for each dollar spent \$35 worth of food was saved. This does not account for the production after the summer period or next season and so on. Besides this work a publicity campaign was carried on to show consumers the value of and ways to use dairy products, and to help the producer by pointing out more economical practices. In all about 4,500,000 sheets of publicity material were distributed to consumers, manufacturers and producers.

It is very necessary that the skimmed milk be used for human food and therefore, it must be made up in some practical manner so that it can be used. The food administration urges us again and again to use exclusively perishable products so that the staples may be distributed and shipped to other countries after our own country is supplied. Every time we use cottage cheese (every pound is equal approximately to one pound of meat,) one pound of meat can be released for shipment abroad.

I do not know how you feel about this work, but I believe that the dairy interests should and can do a great deal through their various channels to stimulate the use of the dairy by-products, as well as working to increase production. That is a part of their work to increase the available food supply.

Now it is a comparatively easy matter to increase the produc-

tion of wheat if the price is sufficiently attractive, because wheat can be sown in the fall or in the spring, and it does not affect materially the organization of the farm whether a few acres more wheat is sown or not. Such is not the case with dairies. It takes two years to raise cattle to the producing age. Ever since the declaration of war there has been a great deal of nervousness about the sale of cattle, and in some communities it has been justified. In some sections considerable numbers of dairy cattle have been sold for one reason or another, possibly in some cases because of the high prices received for them, and in others the difficulty in obtaining labor. A gentleman told me today that manufacturing plants in his vicinity had taken all his men at prices he could not meet. Some feel that the draft is affecting the farm seriously. On the other hand, the draft has affected all the other industries, and it is vital to our national policy. As to how that draft can be changed to improve conditions I am not able to express an opinion.

The question of properly maintaining the industry seems to me, is very important and should have the full consideration of every dairy organization. I think the nervousness about the dairyman being forced out of business has been too great. Some farmers have been, perhaps, a little too quick to become uneasy. It is well to fully realize before abandoning an enterprise the time it takes to organize a farm for successful dairying. It is not the part of wisdom to tear that organization to pieces in a month, when it is realized that the time required to bring it back to the same point, and the importance of the industry in the years to come, is very great.

Can we not appeal to the small farmers who are doing their own work to carry dairy cattle to the extent of the labor and roughage that is available? Can we not encourage the saving of good dairy cattle? Certainly there never was such a good opportunity for the culling out of inferior and diseased animals.

In addition to the utilization and saving of good cattle we have the question of saving the heifers that will shortly reach the producing age. I know that you are thinking about these things and handling them the best you can, but I want to say

that there is no time, that there has been no time in the memory of any here assembled, in which it was more vital for us to harmonize our efforts and our work,—to work together, than now.

We of the Department of Agriculture seek an opportunity to coöperate with you in dealing with these questions, in lending our help to yours in dealing with the problems in the various regions in such way as will help to maintain the industry, and make it bring the greatest good to the country at this, perhaps the most important time in the whole history of the nation.

Let us know how we can help you, and we shall ask the privilege of calling on you, as we have done in the past, to take up these questions and maintain the industry and to increase production in every way possible.

Courses along the lines of the utilization of dairy by-products should be established as a part of the winter short course. In that way we can impress upon the short course as well as the long course students the necessity of utilizing these by-products on the farm as well as in the factory, in the most economical way. A great deal of good can be accomplished if we will give the time and effort.

I wish I had something to suggest that would offer a quick and ready solution of our present problem. This is a period which demands the most thorough system of agriculture that this nation has ever used. It is not the time for launching into uncertainties, but it is a time for the most careful, the most thorough, definite, solid and substantial agriculture that we have ever had; and I believe the present conditions will bring about a better dairy industry. I have given you a glimpse of our plans and aims and what we have already done in the short time elapsed. At this time we must all stand together to render all possible service to the industry and through that, to the nation.

ADDRESS

H. E. VAN NORMAN¹

Davis, California

I do not wish to prolong this meeting, but it so happened that my office is so far away from the Secretary's office—and I missed my program—that I made another engagement for this evening, in the multiplicity of activities that are now going on.

I am glad that I have been able to be in for this afternoon. I have heard more discussion than ever before it seems to me.

There are some thoughts that I would like to leave with the Association members. We have a pretty live bunch of young men here engaged in the dairy divisions of our institutions of the United States today, and they are concerned and confronted with some gigantic problems in the reorganization of society that is in progress today, and I want to urge each one of our dairy instructors to look about him and be sure that he is doing to the limit of his measure of ability his part in that great big indefinite, indefinable problem which is before all of us. How are we going to solve this great problem that we have before us—this shocking thing that is dealing destruction in all parts of the world.

Wherever I have been since I came to Columbus where two or three people are gathered together, there somebody is talking over the problem of the price of milk. What is the province of the Dairy Instructors in helping to solve that problem.

As near as I can size it up the government understands that we are all working to fix a fair price for milk. Can we do it? Are you willing to be one of a committee of five to say to the American people what is a fair price for the farmer to receive for milk throughout the United States? I am not.

This problem of a price to the producers must be worked out.

¹ President of the National Dairy Show.

locally. There are too many variable factors to permit of a national solution. Has your dairy division in your college got the man in it whose experience and judgment make him the most helpful agency in your state for solving that vexing problem?

It seems to me that our college departments ought to be in that position—that they are the most useful agencies available to solve such problems. But I sometimes wonder if they do not get so busy with extension and educational work that they cannot do this kind of work which qualifies them to render that assistance and that service in the marketing of our dairy products, and other agricultural products the immensity of the problems now confronting us demand. Someone has said that our city thinkers must take a larger interest in solving the problems of the relations of rural and city life than they have been doing in the past. It is interesting to note that the war has brought to the considerations of these problems, many people not heretofore concerned with rural problems. Through the State Council of Defense of Massachusetts it devolved upon a leather man to settle the milk problem in that State. In Washington the general manager of the California Citrus Exchange as a member of Hoover's staff is called upon to take an active interest in the milk problem that now confronts so many sections of the nation. The recent commission to propose a plan for studying and settling the price of milk did not include one head of a dairy department of an agricultural college, but did include a professor of farm management, from an agricultural college. I do not question the ability of any of these men for the position to which they are selected, but I find myself wondering why none of our dairy departments seem to have the men who are wanted to help solve these problems. I believe that those of us charged with the responsibility for selecting the men to conduct the work of our dairy departments and to teach our dairy students should give some thought to the conditions I have just referred to. If we are not attracting to the work of our dairy departments the right type of men or if we are not holding them in our dairy departments after we get them there, should we not make

some changes in our college policies. I have been impressed with the thought that many of our big commercial concerns are employing more highly trained men and spending more money in the study and research along dairy lines than many of our State institutions are doing. I believe it behooves us to think carefully of these things.

Again I am aware of the financial limitations under which many of our departments work, but I believe we should give more thought and effort to bringing into the lime light the good work that has been and is being done. Professor Erf as the representative of The National Dairy Show has secured from our college dairy departments the best exhibit we have had at any Dairy Show. I wonder if we are giving too much attention to extension and teaching work and too little to dairy investigation. Look over the exhibits of Pennsylvania, Iowa, Illinois, Ohio State University and Ohio Experiment Station and see what they are presenting.

As a spectacle this year's Dairy Show exceeds anything we have had before, yet, we have not touched the more fundamental educational aspects of the industry. Our colleges have had but a small part in this great show. I covet for the dairy departments of our colleges a more prominent and influential position, not only in the work of the National Dairy Show, but in the eyes of the great commercial industry which we serve. I very much appreciate this opportunity, Mr. President, to say a word to this Association of which I am not only a charter member, but I think a pre-charter member. At the first graduate school of Agriculture at the Ohio State University upon the invitation of Prof. J. J. Decker, there gathered in his home some ten or fifteen men who were teaching dairying in their respective institutions. It was the memory of these successful gatherings that prompted the organization of the Official Dairy Instructors' Association, now the American Dairy Science Association. It did not run itself. Its members have made it.

May I also express my appreciation of the splendid work that Professor Frandsen is doing, in giving us an official publication. He has intimated that he is short of suitable material

for publication. It is up to us who are here to furnish him this material and keep up the high standard he has set in the initial numbers of the Dairy Science Journal.

Some college men dislike notoriety, but still there is such a thing as undue modesty. We should write of the things we think and let the editor decide whether they will help our profession if published. Let us do everything we can to second his efforts.

RESOLUTIONS

The following resolutions were presented and adopted:

Whereas, the dairy products of this country represent approximately 18 per cent of the total food supply of the nation:

BE IT RESOLVED, that the members of the American Dairy Science Association assembled at its twelfth annual meeting, individually and collectively pledge to the National Food Administration their support and constant efforts to increase and conserve the dairy products of the country.

BE IT FURTHER RESOLVED, that the directory of this Association be instructed to send a copy of this resolution to Herbert Hoover, National Food Administrator.

Whereas, the success of the dairy cattle and dairy products student judging contest has been made possible by the coöperation of the Dairy Division of the United States Department of Agriculture:

BE IT RESOLVED, that the American Dairy Science Association extend its appreciation and thanks to Chief B. H. Rawl and all who have assisted in the work, especially to Helmer Rabild, S. C. Thompson and J. A. Gamble.

Whereas, the scholarships and silver cups offered in the students' judging contest add materially to the interest of these contests; and,

Whereas, these scholarships are making possible the training of men in dairy science,

BE IT RESOLVED, that the American Dairy Science Association extend to all donors of scholarships and silver cups its appreciation and thanks;

BE IT FURTHER RESOLVED, that a copy of this resolution be sent to each of the donors.

Whereas, the Journal of Dairy Science has been published, and the first issues distributed;

Whereas, this association is greatly benefitted by the publishing of the Journal, and

Whereas, the editor has labored untiringly in the inception and publishing of a creditable Journal,

BE IT RESOLVED, that a vote of thanks of the Association be here with expressed to the Editor-in-Chief, Professor J. H. Frandsen.

FRED RASMUSSEN, *Chairman*,
ERNEST KELLY,
B. H. THOMPSON,
C. C. HAYDEN,
Committee.

ELECTION OF OFFICERS

The following officers were re-elected for the ensuing year:

President: Prof. W. A. Stocking, Ithaca, New York.

Vice-President: Prof. A. C. Anderson, East Lansing, Michigan.

Secretary-Treasurer: Prof. M. Mortensen, Ames, Iowa.

The officers constitute the Executive Committee of the Association.

COMMITTEES APPOINTED BY AMERICAN DAIRY SCIENCE ASSOCIATION, 1917

Dairy Farm Score Card: Ernest Kelly, *Chairman*; C. B. Lane, W. A. Stocking, I. C. Weld, H. A. Harding.

Milk Quality: H. A. Harding, *Chairman*; W. A. Stocking, R. S. Breed, E. G. Hastings.

Bacteriological Methods for Market Milk Analysis: R. S. Breed, *Chairman*; L. A. Rogers, E. G. Hastings, G. C. Supplee, B. W. Hammer.

State and National Brands for Butter and Cheese: M. Mortensen, *Chairman*; C. E. Lee, C. Larsen, N. W. Hepburn, F. W. Fisk.

Cream Grading: J. H. Frandsen, *Chairman*; F. W. Bouska, G. S. Hine, C. W. Larsen.

Legal Limits for Ice Cream: R. M. Washburn, *Chairman*; O. F. Hunziker, M. Mortensen, W. W. Fisk.

Official Methods for Testing Butter for Butter Fat: H. C. Troy, *Chairman*; E. C. Gray, J. M. Barnhardt.

Official Methods for Testing Milk and Cream for Butter Fat:

O. F. Hunziker, *Chairman*; F. W. Bouska, Fred Rasmussen, H. C. Troy, L. A. Rogers.

Methods of Conducting Students Dairy Products Judging Contest: W. P. B. Lockwood, *Chairman*; M. Mortensen, C. E. Lee, E. S. Guthrie, H. C. Mills, R. L. Lang.

Methods of Conducting Students Dairy Cattle Judging Contests: Helmer Rabild, *Chairman*; H. H. Wing, H. H. Kildoe, E. G. Woodward, William Regan, E. L. Anthony.

Relation to Breed Associations: C. H. Eckles, *Chairman*; H. E. Van Norman, H. H. Wing, E. G. Woodward, Roy T. Harris, G. C. Buckley.

Statistics of Milk and Cream Regulations: I. C. Weld, *Chairman*; E. H. Farrington, G. A. Gamble, H. E. Ross, Roy C. Potts.

Courses of Instruction for Dairy Inspectors: Oscar Erf, *Chairman*; H. E. Van Norman, A. C. Anderson, I. C. Weld, Ernest Kelly.

Feeding Standards for Milk Production: C. Larsen, *Chairman*; C. H. Eckles, F. S. Putney, Helmer Rabild, A. A. Borland, E. S. Savage.

Legal Limits for Butter: B. D. White, *Chairman*; J. G. Winkjer, G. H. Benkendorf, C. C. Cunningham,

Graduate Instruction in Dairying: R. A. Pearson, *Chairman*; C. E. Marshall, C. W. Larsen.

International Dairy Congress: Fred Rasmussen, *Chairman*; B. H. Rawl, R. S. Breed, O. F. Hunziker, M. Mortensen.

Revision of Constitution and By-Laws: C. H. Eckles, *Chairman*; Fred Rasmussen, O. F. Hunziker, M. Mortensen, W. J. Fraser, R. A. Pearson, J. H. Frandsen.

Statistics on Marketing of Dairy Products: Roy C. Potts, *Chairman*; O. F. Hunziker, S. C. Thompson, C. E. Lee, L. M. Davis.

NAMES AND ADDRESSES OF MEMBERS IN ATTENDANCE

M. Mortensen.....	Iowa State College, Ames, Iowa
A. J. Glover.....	Fort Atkinson, Wis.
R. B. Stoltz.....	Ohio State College, Columbus, Ohio
W. W. Yapp.....	College of Agriculture, Urbana, Ill.
N. W. Hepburn.....	College of Agriculture, Urbana, Ill.
Ernest Kelly.....	Washington, D. C.
W. A. Stocking.....	Ithaca, N. Y.
H. E. Droracheke.....	Fayetteville, Ark.
E. M. Clark.....	Urbana, Ill.
R. I. Grady.....	Ohio Agriculture Experiment Station, Wooster, Ohio
P. H. Crane.....	Lebanon, Ind.
S. I. Bechdel.....	State College, Pa.
H. C. Yerger, Jr.....	Pennsylvania State College, State College, Pa.
Fred Rasmussen.....	Pennsylvania State College, State College, Pa.
R. R. Latz.....	Pennsylvania State College, State College, Pa.
H. A. Torry.....	Pennsylvania State College, State College, Pa.
R. S. Clark.....	Pennsylvania State College, State College, Pa.
David Breman.....	Pennsylvania State College, State College, Pa.
Karl B. Musser.....	Connecticut Agriculture College, Storrs, Conn.
R. S. Hulce.....	Rock River Farms, Byron, Ill.
Wm. Regan.....	New Jersey Experiment Station, New Brunswick, N. J.
L. S. Riford.....	Plainsboro, N. J.
J. B. Fitch.....	Manhattan, Kans.
J. A. Clutter.....	Clemson College
E. V. Ellington.....	U. S. Dairy Division, Washington, D. C.
R. R. Graves.....	U. S. Dairy Division, Washington, D. C.
A. C. Ragsdale.....	University of Missouri, Columbia, Mo.
W. J. Fraser.....	University of Illinois, Champaign, Ill.
Roy C. Potts.....	Bureau of Markets, Washington, D. C.
Ivan C. Weld.....	Chestnut Farms Dairy, Washington, D. C.
C. B. Lane.....	Supplee Milk Company, Philadelphia, Pa.
J. A. Gamble.....	Dairy Division, Washington, D. C.
J. H. Frandsen.....	University of Nebraska, Lincoln, Nebr.
B. H. Thompson.....	University of Nebraska, Lincoln, Nebr.
F. H. Hozer.....	University of Arkansas, Fayetteville, Ark.
A. L. Beam.....	Penn State College, State College, Pa.
E. L. Anthony.....	Penn State College, State College, Pa.
Geo. S. Bulkley.....	Penn State College, State College, Pa.
L. C. Tomkins.....	Penn State College, State College, Pa.
C. W. Larson.....	Dairy Division, Washington, D. C.

G. L. Martin.....	Bozeman, Mont.
J. M. Cadwallader.....	Baton Rouge, La.
C. Larsen.....	State College, Brookings, S. D.
J. W. Ridgway.....	
Texas Agriculture and Mechanical College, College Station, Texas	
W. D. Nicholls.....	Kentucky State University, Lexington, Ky.
C. C. Cunningham.....	Ohio State University, Columbus, Ohio.
C. W. Holdaway.....	Virginia Polytechnic Institute, Blacksburg, Va.
C. L. Roadhouse.....	University Farm, Davis, Calif.
Leon M. Davis.....	Washington, D. C.
A. E. Perkins.....	Ohio Agriculture Experiment Station, Wooster, Ohio
S. M. Salisbury.....	Ohio State University
J. C. McNutt.....	Amherst, Mass.
R. S. Pau.....	College Station, Texas
J. C. Patterson.....	Texas Department Agriculture, Austin, Texas
W. P. B. Lockwood.....	Massachusetts College, Amherst, Mass.
H. C. Harding.....	College of Agriculture, Urbana, Ill.
W. W. Swett.....	University of Missouri, Columbia, Mo.
W. B. Combs.....	New Jersey Experiment Station
R. H. Ruffner.....	Maryland State College, College Park, Md.
C. C. Hayden.....	Ohio Agriculture Experiment Station, Wooster, Ohio
A. C. Anderson.....	Michigan Agriculture College, East Lansing, Mich.
William White.....	Dairy Division, Department of Agriculture
Roy T. Harris.....	Wisconsin Agriculture College, Madison, Wis.
C. L. Willoughby.....	University of Florida, Gainesville
J. D. Jarvis.....	West Lafayette, Ind.
W. L. Clevenger.....	Dairy Division, Knoxville, Tenn.
C. H. Eckles.....	University of Missouri, Columbia, Mo.
H. P. Davis.....	Dairy Division Department of Agriculture, Washington, D. C.
M. J. Prucha.....	University of Illinois, Urbana, Ill.
R. S. Breed.....	Geneva, N. Y.

LIST OF MEMBERS

The following is a complete list of the active members of the American Dairy Science Association whose dues have been paid to date. In some cases it has been difficult to get correct addresses and members will confer a great favor if they will send any necessary corrections to Secretary Mortensen, Ames, Iowa.

At the last annual meeting of the Association the following action was taken:

Moved: that any member whose dues were two years in arrears and who does not pay his dues within thirty days, will be notified that his name is automatically dropped as a member of this Association.

Your officers desire to give delinquent members every opportunity to continue their membership. They may still do so by sending their back dues to Secretary Mortensen, but if this is not done soon it will be necessary to follow the instructions of the Association and drop their names from the list. We hope all former members will consider membership in the Association of sufficient value so that they will want to continue in active relations with it.

Respectfully submitted,

W. A. STOCKING,
President.

Paid-up Members American Dairy Science Association, March 21, 1918

ANDERSON, A. C., Agriculture College, East Lansing, Mich.

ANTHONY, E. L., State College, Pa.

BARNES, S. E., DeLaval Separator Company, New York, N. Y.

BEAM, A. LELAND, Pennsylvania State College, State College, Pa.

BECHDEL, S. I., Pennsylvania State College, State College, Pa.

BENKENDORF, G. H., University of Wisconsin, Madison, Wis.

BILLINGS, G. A., Department Farm Management, Washington, D. C.

BORLAND, ANDREW A., Pennsylvania State College, State College, Pa.

BOUSKA, F. W., 2037 Continental and Commercial Bank Building, Chicago, Ill.

BRANDT, P. M., Oregon Agriculture College, Corvallis, Ore.

BREED, R. S., Geneva, N. Y.

BROWN, R. W., Manitoba Agriculture College, Winnipeg, Canada.

BUCKLEY, G. S., Pennsylvania State College, State College, Pa.

BURLINGHAM, C. L., Care of *Hoard's Dairyman*, Ft. Atkinson, Wisc.

BURNETT, J. E., East Lansing, Mich.

BROWNELL, S. J., Department Dairy Husbandry, East Lansing, Mich.

BAILEY, D. E., Iowa State College, Ames, Iowa.

CAINE, GEO. B., Logan, Utah.

CALDWALLADER, J. M., Baton Rouge, La.

CALDWELL, R. E., Lafayette, Ind.

CAMPBELL, GLENN H., Storrs, Conn.

CLEVINGER, W. L., Extension Division, Knoxville, Tenn.

CLUTTER, J. A., Clemson College, S. C.

CORBETT, L. S., Orono, Me.

CUNNINGHAM, O. C., Ohio State University, Columbus, Ohio.

COMBS, W. B., New Jersey Agriculture Extension, New Brunswick, N. J.

CORNELIUSSEN, THOS., Dairy Division, Washington, D. C.

DAHLBERG, A. O., Dairy Division, Grove City, Pa.
DAVIS, H. P., Dairy Division, Washington, D. C.
DAVIS, LEON M., United States Bureau of Markets, Washington, D. C.
DICE, J. R., Morrisville, N. Y.
DRAIN, HARRY D., Amherst, Mass.

ECKLES, C. H., Columbia, Mo.
ELLENBERGER, H. B., Berwick Hotel, Rutland, Vt.
ERF, OSCAR, Columbus, Ohio.

FISK, W. W., Ithaca, N. Y.
FITCH, J. B., Department Dairy Husbandry, Manhattan, Kans.
FITTS, E. B., Oregon Agriculture College, Corvallis, Ore.
FORBES, WILL, Associate Manufacturing Company, Waterloo, Iowa.
FRANDSEN, J. H., College of Agriculture, Lincoln, Nebr.
FRASER, W. J., Champaign, Ill.
FRYHOFFER, C. W., R. F. D. 3, Plainfield, N. J.
FULLER, J. M., New Hampshire Agriculture College, Durham, N. H.
FINKELSTEIN, R., Department of Bacteriology, Agriculture College, Guelph, Canada.

GAMBLE, J. A., Bureau Animal Industry, Washington, D. C.
GLOVER, A. J., *Hoard's Dairyman*, Ft. Atkinson, Wisc.
GRAVES, R. R., Oregon Agricultural College, Corvallis, Ore.
GRAY, C. E., 425 Battery Street, San Francisco, Calif.
GUTHRIE, E. S., Cornell University, Ithaca, N. Y.
GRADY, ROY, Ohio Experiment Station, Wooster, Ohio.
GOSS, E. F., University of Idaho, Moscow, Idaho

HAECKER, A. L., care of Woods Bros. Silo Company, Lincoln, Nebr.
HAECKER, T. L., St. Anthony Park, Minn.
HARDING, H. A., University of Illinois, Urbana, Ill.
HARRIS, R. T., Animal Husbandry Department, Madison, Wis.
HAUSER, A. J., Dairy Department, Ames, Iowa
HAYDEN, C. C., Experiment Station, Wooster, Ohio
HEPBURN, N. W., Urbana, Ill.
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HOPPER, H. A., Cornell University, Ithaca, N. Y.
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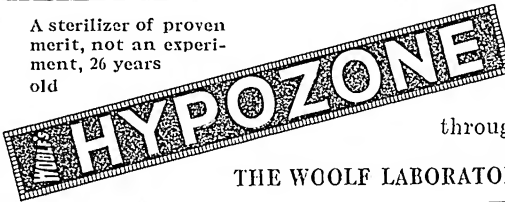
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states alfalfa is generally used as a part of the hay ration or as a soiling crop for dairy cattle and young stock, also to a smaller extent for other classes of farm animals—fattening steers, horses, sheep and swine. It is nearly always fed in connection with other roughage and with grain feeds, the greatest advantage derived from its use being that it will reduce the amount of concentrates, especially high-protein feeds, that stock require for a large production, as has been shown by investigations at the New Jersey and other experiment stations.² The experiments have established the fact that a considerable proportion of the concentrates in the rations for dairy cows may be replaced by alfalfa without an appreciable decrease in production; this will result in a lowering of the cost of the rations fed, since alfalfa is a farm-grown feed which where well established, will, as a general rule, produce larger amounts of feed materials per unit of land than any other forage crop with the exception of Indian corn. In ground form, alfalfa is also used as a partial substitute for mill feeds and other concentrates, especially in feeding swine and poultry. In no case, however, is alfalfa used as the sole feed for farm animals as a regular practice in the eastern United States, so far as known. This is a distinct western practice, and confined to the irrigated regions of the semi-arid west where alfalfa culture reaches its highest development. Here, as in the east, alfalfa is fed primarily to dairy cows, but other classes of farm stock, beef cattle, sheep and even hogs, likewise frequently receive nothing but alfalfa throughout the year, alfalfa pasture or green alfalfa during the growing season, and alfalfa hay in the winter. We are here chiefly concerned with this practice in so far as it relates to the feeding of dairy cows, and may say at the outset that no ill effects apparently result from this monotonous diet, as might be supposed. On the contrary, both from the standpoint of efficiency of nutrients supplied and economy of production, there seems to be no reason to condemn offhand the system of feeding. The fact that tens of thousands of dairy farmers in

² Reports 1888, p. 910; 1903, p. 396; Bulletins nos. 148, 174 and 204; Maryland Bulletin, no. 98; Tennessee Bulletin, xvii, no. 74; Kansas Bulletin, no. 125.

these western states have followed the method of exclusive alfalfa feeding as a fixed practice for years and years at once suggests that it can hardly be seriously at fault and cannot be pronounced either irrational or wasteful except on the basis of very careful clinching experimental evidence.

For the purpose of ascertaining the facts as to the value of alfalfa as the sole feed for dairy stock, an investigation was begun at the California Station about three and one-half years ago. A number of young dairy heifers have since that time been fed alfalfa only, up to freshening and during one or two lactation periods, under conditions that permitted control of the amounts of feed eaten, the rate of the growth of the animals, and their dairy production. At the same time, an equal number of animals, as nearly similar to the others as possible in age, breeding, type, and condition, have been fed according to the best dairy practice prevailing in the state, on mixed rations of alfalfa hay, silage, and a fair amount of concentrates. The investigation was begun in April, 1914, with six pure-bred dairy heifers, three of which were placed on alfalfa only, and the other three on mixed rations. Each lot consisted of one Holstein heifer and two Jersey heifers. The animals were about one and one-half years old at the beginning of the experiment and one year from freshening. All six heifers have now finished their second lactations and data are available for their production and feed consumption during the two periods.

In December, 1915, another group of six yearling calves, all high-grade Holsteins, were placed on a similar experiment, three of which have since been fed alfalfa only and the other three, mixed rations similar to those fed in the first group. Five of these heifers have now finished their first lactation,—three fed alfalfa only and two fed mixed rations. We have, therefore, at the present time records of 9 lactation periods in all for heifers receiving alfalfa, and 9 for heifers of similar age and breeding, fed rations of alfalfa hay, silage and mixtures of various concentrates, mainly rolled barley, dried beet pulp, cocoanut meal, and wheat bran. The following table will show the more important facts relating to individual heifers included in the experiments.

TABLE 1
Heifers included in experiment, 1914-1917

	BREED	BORN	PLACED ON TRIAL	INITIAL BODY WEIGHT	DATES OF CALVING	REMARKS
				pounds		
<i>Group A</i>						
Lot I, fed alfalfa only:						
Bess Fayne Concordia.....	H	June 1, 1913	April, 1914	617	{ November 11, 1915 December 29, 1916 January 25, 1915 February 11, 1916 March 13, 1917	
Jap's Rose.....	J	September 9, 1912	April, 1914	668		
Fancy Dolly Marigold 2d*....	J	September 14, 1912	April, 1914	723		
Begonia's Adelaide 2d.....	J	March 2, 1913	March, 1915	807	{ May 15, 1915 April 22, 1916 May 11, 1917	
Lot II, fed mixed rations:						
Bess of Hopland 3d†.....	H	March 23, 1913	March, 1915	693	{ August 22, 1915 August 30, 1916 March 18, 1916 April 26, 1917	
Univ. La Polka Lady 2d.....	H	August 25, 1913	March, 1916	1200		
Mermalden's Fern 2d.....	J	September 16, 1912	April, 1914	691	{ December 27, 1917 February 20, 1916 September 24, 1917 January 22, 1915 February 21, 1916 April 5, 1917	
Meridale Jap's Nora.....	J	October 21, 1912	April, 1914	631		
<i>Group B</i>						
Lot I, fed alfalfa only:						
Babette.....	Gr. H	November 22, 1914	December, 1915	626	February 7, 1917	
Marie.....	Gr. H	November 18, 1914	December, 1915	696	November 7, 1916 November 7, 1916	
Fairie.....	Gr. H	October 10, 1914	December, 1915	696	October 8, 1916	Aborted
Lot II, fed mixed rations:						
Paula.....	Gr. H	December 6, 1914	December, 1915	658	{ November 28, 1916 December 9, 1917	Calf dead†
Gwendolin.....	Gr. H	October 12, 1914	December, 1915	704	February 2, 1917	
Duchess.....	Gr. H	November 20, 1914	December, 1915	666	{ November 24, 1916 November 10, 1917	Aborted Aborted

The object of the present paper is to present briefly the more important results that have been obtained in the investigation up to the present time and to ascertain in how far these will throw light on the question of the value of exclusive alfalfa diet for dairy cows and its physiological effects on the body development and the dairy production of the animals.

The heifers were measured and weighed once a month during the first year. After freshening, they were weighed regularly once every week, and measurements were taken every two or three months. The following measurements were taken: (a) height of shoulders, (b) height of hips, (c) width of hips from outside of one hook bone to the outside of the other, (d) length of hips, from front of hip bone to rear of pin bone, (e) body length from extreme front of shoulder point to extreme rear of pin bone, (f) girth; the circumference of the barrel 1 to 2 inches back of the front legs.

Great care was exercised to always take the weights and measurements of the heifers under comparable conditions and with a similar fill. It has been our effort in the feeding and management of the animals on the experiment to give them all the feed they would eat with a keen appetite and to keep them as comfortable as the conditions would permit. All feeds were weighed out to the animals, and the milk produced was weighed and composite samples taken that were tested once a week. Chemical analyses were made of samples of all feeds used in the investigation, through the kind assistance of Prof. M. E. Jaffa, Chief of the Nutrition Laboratories at Berkeley, but the study of the metabolic processes involved in the alfalfa feeding was necessarily postponed until provisions for biochemical work can be made at the University Farm.

In studying the effects of the two feeding practices investigated, we shall give and discuss summary results only for the two groups of animals included in the experiments, but the data for the individual animals have been carefully scrutinized in interpreting the results. The influence of the two systems of feeding will be traced in the following order: the increase in body weight and in the body measurements taken throughout the investigation; the

* Suffered from fractured joint, killed March, 1915; replaced by Begonia's Adelaide 2d.

† Sold October, 1916; replaced by University La Polka Lady 2d.

‡ Killed in removing it from the cow; a big, strong, normal calf.

influence on the calves dropped; the production of milk and butter fat during each lactation period, and the relation of the feed eaten to the dairy production.

A. Influence on gain in body weight and measurements. The average results obtained as regards gain in body weights for the two lots of heifers in groups A and B will be seen from the following table.

TABLE 2
Increase in body weight of heifers

	LOT I ALFALFA ONLY	LOT II MIXED RATIONS
	pounds	pounds
<i>Group A:</i>		
Average weight at beginning.....	702.0	672.0
Daily gain prior to freshening*.....	0.88	0.91
Daily gain for entire period†.....	0.36	0.40
<i>Group B:</i>		
Average weight at beginning.....	673.0	676.0
Daily gain prior to freshening‡.....	1.29	1.32
Daily gain for entire period§.....	0.65	0.79
<i>Average for both groups:</i>		
Daily gain prior to freshening.....	1.05	1.11
Daily gain for entire period.....	0.50	0.60

* 324 and 302 days, respectively.

† 1117 and 1054 days, respectively.

‡ 252 days.

§ 639 days.

Larger average daily gains were secured on the mixed rations than on alfalfa hay, in case of both groups of heifers, the former gaining 1.11 pounds on the average before freshening, against 1.05 pounds for the alfalfa heifers, and 0.60 pound during the entire period against 0.50 pound for the alfalfa heifers, an average difference of 0.10 pound, or 20 per cent in favor of the mixed diet. These results are rather striking, and indicate clearly a superior nutritive effect of the mixed rations, so far as gain in body weights goes.

Instead of figures for the actual measurements taken during the progress of the investigation, the percentage increase in corresponding measurements during the record period is given in

the table below. The average increase in measurements during the full period of the investigation for the two lots is given separately and also for both combined.

In the case of both lots somewhat higher figures were obtained for the percentage increase during the period before freshening, and during the first or the second lactation periods, for the

TABLE 3

Measurements of heifers, with percentage increase, in inches

	LOT A AVERAGE FOR 8 ANIMALS		LOT B AVERAGE FOR 6 ANIMALS		AVERAGE FOR BOTH LOTS	
	Alfalfa only	Mixed rations	Alfalfa only	Mixed rations	Alfalfa only	Mixed rations
Height of shoulders, inches.....	47.2	49.5	46.4	46.8	46.9	48.3
Per cent increase.....	5.0	4.0	11.0	13.0	8.0	8.0
Height of hips.....	47.8	49.3	47.4	47.7	47.6	48.6
Per cent increase.....	4.0	4.0	9.7	9.3	6.0	6.0
Width of hips.....	17.6	18.0	15.5	15.3	16.7	16.9
Per cent increase.....	21.0	17.0	34.0	37.0	26.0	26.0
Length of hips.....	18.6	19.0	16.5	16.5	17.7	17.9
Per cent increase.....	14.0	12.0	24.0	28.0	19.0	19.0
Body length.....	54.3	56.0	51.9	51.9	53.3	54.3
Per cent increase.....	16.0	16.0	19.0	22.0	17.0	18.0
Girth.....	63.6	67.7	61.7	61.3	62.8	64.9
Per cent increase.....	10.0	10.0	15.0	19.0	12.0	14.0
Length of period, days.....	846.0	820.0	640.0	640.0	758.0	743.0

heifers fed mixed rations than for the alfalfa heifers, but these differences disappear when longer periods or when summary data for both lots are considered, except for increase in body length and girth measure. While the evidence cannot be considered conclusive, the tendency is toward a slightly larger body development of the animals on the mixed rations than of those on alfalfa only.

The average increase in height of shoulders for the alfalfa heifers in group A was 2.53 inches and for lot II, 2.03 inches, while the measurement for width of hip increased 3.43 and 2.9 inches for lots I and II, respectively. The ratio of increase of the latter to the former measurements is, therefore, as 1 : 0.74 for the alfalfa heifers and 1 : 0.70 for those on mixed feed. The corresponding figures for group B were 3.75 and 3.95 inches for increase in height of shoulders and width of hips, respectively, for the alfalfa heifers, and 4.53 and 4.3 inches for lot II, or a ratio of width of hips to height of shoulders of 1 : 0.83 and 1 : 0.92 for alfalfa and mixed diet, respectively.

It will be noted that the two systems of feeding studied in this investigation did not produce appreciable differences in the rate of increase in width of hips and body height. It is not to be assumed that the skeletal form and conformation of growing dairy heifers will change in a similar way as that of beef animals, but the results obtained by Waters in his investigation of the influence of nutrients upon the animal form³ suggest that both systems of feeding studied produced normally developed animals in this investigation and that dairy heifers appear to make a somewhat more marked increase in width of hips in comparison with body heights than takes place in the case of well fed young beef cattle or even moderately fed steers making a daily gain in body weight of about 1½ pounds.

The investigations so far cover data for only eight and six animals for groups A and B, respectively, and it is hardly to be expected that individual characteristics largely determined by inheritance, like size, thriftiness and other factors aside from feed consumed, would be evenly balanced for two lots of such small numbers of animals. Hence, the effect of the character of the rations fed on the body development as shown by the different measurements taken, is not necessarily correctly expressed by their results so far obtained. There is, however, no occasion for doubting the correctness of the results showing the greater increase in length of body and girth measurements on mixed

³ 30th Report of Soc. Prom. Agr. Sc., p. 70; see also Jr. Agric. Research, vol. xi, p. 383.

rations than alfalfa only. Nor can there be any doubt as to the effect of the rations on the increase in body weight of the animals during the period covered by the measurements, 25 months. The gains for the heifers of the different breeds in practically all cases were larger for those on mixed rations than for those on alfalfa only. The former gained 44 per cent and 75 per cent for groups A and B, respectively, and the latter 41 per cent and 62 per cent, a difference of 7 per cent in the averages for both groups (57 per cent vs. 50 per cent).

B. Influence on calves dropped. Twenty-six calves have been dropped by the heifers on the experiment to date, there being six Jersey calves, and seven pure-bred or grade Holstein calves in each group. The alfalfa heifers dropped six bull calves and seven heifers, and those on mixed diet dropped five bull calves and eight heifers. One heifer on alfalfa only aborted, one on mixed diet aborted twice, and two on alfalfa diet dropped dead calves. The University dairy herd has been relatively free from abortion up to the present time, and the showing for the alfalfa heifers in this respect is considerably worse than might be expected. There is no definite evidence of causal relation between the alfalfa diet and the appearance of abortion, however, although the belief that such a relation exists is held by many dairy farmers and might be accounted for by the effect of excessive protein feeding on the vitality of the animals.⁴ The only study of this question known to the writer failed to show that abortion or sterility in dairy cattle is more common in regions where exclusive alfalfa feeding is practiced than where practically no alfalfa is fed to the cows; in fact, the evidence appeared to be the other way.⁵

The calves dropped by the alfalfa heifers weighed, on the average, 59.8 pounds at birth (range 33 to 83 pounds), and those dropped by heifers on mixed rations averaged 64.4 pounds (range 41 to 90 pounds), an increase of 8 per cent in the average birth weight of the latter calves. The calves dropped by the Jersey

⁴ See e.g., Pacific Rural Press, September 19, 1914 and December 8, 1917; Kimball's Dairy Farmer, December 15, 1914 and February 1, 1915.

⁵ California Experiment Station, report 1914-1915, p. 34.

heifers fed alfalfa weighed 43.2 pounds, against 45.7 pounds for calves dropped by the Jerseys on mixed rations, the corresponding weights for the Holstein calves being 76.3 pounds and 83.2 pounds. The calves dropped by the heifers on mixed diet were, therefore, uniformly heavier than those dropped by the alfalfa heifers. The available records are not sufficiently complete, and the number of animals raised not large enough, to show whether or not the heavier calves continued to have the advantage as they grew older, so far as body weight is concerned, but a good-sized thrifty calf is always considered an asset whether it is to be raised or vealed.

C. Influence on dairy production. Complete records of production and of feed consumption for twelve first lactation periods and for six second lactation periods have been completed by the heifers on the experiment up to the present time, one-half of each for the heifers fed alfalfa only and those fed mixed rations. The following table shows the average production for the record period for the two lots of heifers.

We note that the mixed rations have proved decidedly superior to alfalfa only in point of dairy production up to the present time. During the first lactation period the heifers on the mixed rations produced, on the average, 92.86 pounds more butter fat than those fed alfalfa only, an increase of 45 per cent, and during the second lactation period 65.66 pounds more butter fat was produced by the heifers fed mixed rations than by the alfalfa heifers, a difference of 23 per cent in favor of the former. The latter figure was doubtless considerably reduced through the failure of one heifer, University 2d, to make a satisfactory production during this period. For some reason or reasons not clearly understood, she began to drop off rapidly in milk production last July and August, and dried up the middle of October after a lactation of less than six months, making a production during the lactation period of only 167 pounds butter fat against 352 pounds during the first lactation. The feed was undoubtedly not a factor in the case, as there was no material difference in the method of feeding during the two periods.

TABLE 4
Production and feed consumption, 1914-1917

	LENGTH OF LACTATION PERIOD	YIELD PER LACTATION PERIOD			AVERAGE BODY WEIGHT	FEED CONSUMPTION				
		Milk	Butterfat	Fat		Alfalfa hay	Green alfalfa	Silage	Green corn	Grain feeds
	days	pounds	pounds	per cent	pounds	pounds	pounds	pounds	pounds	pounds
<i>* Lot I, alfalfa only</i>										
First lactation period:										
Fayne.....	364	8,854.0	265.28	2.99	1,267	9,079	6,065			
Jap.....	365	5,010.2	251.09	5.01	792	7,870	7,853			
Begonia 2d.....	277	2,670.1	121.44	4.55	861	5,864	7,883			
Maria.....	316	6,021.1	197.70	3.28	1,064	7,904	3,982			
Fairie.....	382	6,467.7	217.45	3.36	940	9,692	4,451			
Babette.....	305	5,435.5	172.20	3.17	1,017	7,312	4,234			
Average.....	335	5,743.1	204.19	3.56	1,007	7,954	5,745			
Second lactation period:										
Fayne.....	345	8,216.8	258.64	3.15	1,334	8,677	4,069			
Jap.....	368	5,221.3	301.76	5.78	891	9,402	5,956			
Begonia 2d.....	348	5,678.4	207.09	5.23	925	8,894	5,072			
Average.....	354	6,372.2	285.83	4.48	1,050	8,991	5,032			
<i>Lot II, mixed rations</i>										
First lactation period:										
Bess III.....	284	5,978.6	166.68	2.79	1,312	4,808	2,452	6,299	629	673
University II.....	366	9,907.0	352.62	3.56	1,169	6,285	3,055	7,692		2,881
Mermaid II.....	399	7,070.1	346.63	4.91	818	5,232	7,509	5,958	1,214	2,238
Nora.....	368	6,548.0	337.21	5.15	877	4,818	7,458	5,381	934	2,590
Duchess.....	351	7,691.5	262.16	3.41	1,110	5,345	2,380	7,528		2,366
Paula.....	359	6,961.0	317.01	4.55	1,057	5,395	2,380	8,056	195	2,260
Average.....	355	7,359.4	297.05	4.04	1,057	5,314	4,206	6,819	495	2,168
Second lactation period:										
University II.....	176	4,702.4	167.39	3.56	1,448	3,200	2,422	2,535	175	1,122
Mermaid II.....	363	10,136.7	519.86	5.13	909	6,659	3,055	8,611		3,955
Nora.....	368	7,419.7	367.23	4.95	1,037	5,901	3,055	7,586		2,786
Average.....	302	7,419.6	351.49	4.74	1,131	5,253	2,844	6,244	58	2,621

Average daily rations fed. The average daily rations fed both lots of heifers during the two lactation periods are shown in the following table, with their contents of dry matter and digestible components, the latter having been computed from the average chemical composition of the various feeding stuffs fed during the progress of the investigation, and from tables showing average coefficients of digestibility.

The average contents of dry matter in the alfalfa rations was 24.9 pounds and in the mixed rations 28.6 pounds, the nutritive ratios being 1 : 3.7 and 1 : 5.3 for the two rations, respectively. By reference to Table IV, it will be noted that the average daily production for the two lactation periods on alfalfa alone was 17.6 pounds of milk and 0.71 pound butter fat, and on the mixed rations 22.7 pounds milk and 1.00 pound butter fat. Each hundred pounds of dry matter supplied in the alfalfa rations, therefore, produced 70.7 pounds milk and 2.82 pounds butter fat, and in the mixed rations 79.4 pounds milk and 3.50 pounds butter fat, an improvement in the latter rations over the former of 12 per cent and 23 per cent in the production of milk and butter fat, respectively.

If the net energy values furnished in the two rations be calculated, the reason for the greater efficiency of the mixed rations is readily seen. Using the average values given in Armsby's "Nutrition of Farm Animals," Appendix, Table VII, it will be found that the alfalfa rations supplied 2.05 pounds of digestible true protein, and a net energy of 9.9 therms, against 2.08 pounds digestible true protein and 15.4 net energy values in the mixed rations. The amount of the production by the alfalfa heifers indicates that the difference in the nutritive effect of the two rations can hardly have been as great as that indicated by the energy values given, and it seems likely that the computed net energy value of the alfalfa ration is too low. According to the average production and body weights of the heifers on alfalfa only, their energy requirements would be approximately 10.7 therms, a figure which is still 4.7 therms (or 44 per cent) below the calculated net energy furnished in the mixed rations.

TABLE 5
Average rations fed and nutrients contained therein

AMOUNT OF FEED	DRY MATTER	DIGESTIBLE	
		Protein	Carbohy- drates and fat
Alfalfa rations			
<i>First lactation period:</i>			
23.7 pounds alfalfa hay.....	20.7	2.54	9.39
17.2 pounds green alfalfa.....	3.8	0.46	1.70
	24.5	3.00	11.09
<i>Second lactation period:</i>			
25.4 pounds alfalfa hay.....	22.2	2.72	10.06
14.2 pounds green alfalfa.....	3.1	0.38	1.41
	25.3	3.10	11.47
Nutritive ratio.....			1 : 3.7
Mixed rations			
<i>First lactation period:</i>			
15.0 pounds alfalfa hay.....	13.1	1.61	5.94
11.8 pounds green alfalfa.....	2.6	0.32	1.17
19.2 pounds silage.....	5.0	0.21	3.17
1.4 pounds green corn.....	0.3	0.01	0.18
6.1 pounds concentrates.....	5.5	0.58	3.86
	26.5	2.73	14.32
<i>Second lactation period:</i>			
17.4 pounds alfalfa hay.....	15.2	1.86	6.89
9.4 pounds green alfalfa.....	2.1	0.25	0.93
20.7 pounds silage.....	5.4	0.23	3.42
8.7 pounds concentrates.....	7.9	0.83	5.50
	30.6	3.17	16.74
Nutritive ratio.....			1 : 5.3

To the dairyman and to the practical mind in general, the question naturally arises,—did the increased production obtained on the mixed rations more than pay for the higher feed cost of these rations? The answer will differ in different sections and

during different seasons, according to the price of feeds and products. Average California market prices for feeding stuffs for the six year period up to and including 1916 were as follows:

	<i>per ton</i>
Alfalfa hay.....	\$10.50
Barley.....	29.00
Dried beet pulp.....	24.00
Cocoanut meal.....	27.00
Wheat bran.....	27.00

Taking average feed prices like these as a basis for calculations,⁶ we find that the alfalfa rations cost \$56.34 and \$61.49 for the first and second lactations, respectively, the corresponding figures for the mixed rations being \$84.51 and \$87.71, an increase in the average feed cost of \$28.17 for the first lactation period and of \$26.22 for the second lactation period. The increase in average production secured, leaving out of consideration the greater value of the calves dropped by the heifers on the mixed rations, and the larger amount of skim milk furnished by these heifers, was in round numbers 93 and 66 pounds of butter fat, for the first and second lactation periods, respectively, or an average cost of 33 cents and 25 cents a pound of increase in butter fat. These are average and below average figures, respectively, for butter fat during the period for which the cost of the ration was estimated. It would, therefore, seem that it is about an even break in the economy of the two systems of feeding considering average market prices for feeds that prevailed up to the current year. At war prices, the alfalfa rations will have a decided advantage, as the increase in cost has so far been proportionately less for this feed than for concentrates. In years past, the dairy farmers in our state have been accustomed to receiving or paying \$8.00 a ton for alfalfa in the stack. Evidently, at this figure and with prices of grain and other common concentrates at \$20.00 to \$30.00 a ton, there is no direct gain to be expected by changing from clear alfalfa to a mixed ration.

Whether or not other factors, like the influence of the rations fed on the condition of the cows themselves or on their calves,

⁶ The exact prices assumed are: alfalfa hay, \$12.00; green alfalfa or green corn, \$3.00 per ton; corn silage, \$4.00 per ton, and concentrates \$30.00 per ton.

would render it advisable to give a variety of feeds, cannot be definitely stated from the results now available, but the evidence would not probably be sufficiently strong to commend this method of feeding to the judgment of the average dairyman. As a matter of general interest, it may be said that exclusive alfalfa-feeding for dairy cows has frequently produced excellent results in the past, both in the case of individual cows and whole herds; for example, one herd of 23 cows in one of the California Cow-Testing Associations last year averaged 410 pounds of butter fat on no other feed than alfalfa from the beginning of the year to the end. The results to which this investigation has led so far show clearly, however, that the production of good dairy-bred heifers can be appreciably increased by feeding a variety of feeds, and that the body development of both calves and young dairy stock is, in general, improved by this system of feeding. With the results of the investigation before him, a dairyman can readily decide whether or not he will be justified in feeding rations containing feeds from different plant sources and including expensive concentrates under the special conditions under which he is operating his dairy.

STUDIES ON THE UNIFORMITY OF HEATING IN THE FINAL PACKAGE METHOD OF PASTEURIZATION

B. W. HAMMER AND A. J. HAUSER

Department of Dairying, Iowa State College, Ames, Iowa

INTRODUCTION

In the long series of studies and experiments that have led to the evolution of the common methods of pasteurization in use today, the necessity for the uniform heating of a given lot of milk has been widely considered. The main reason for uniform heating during pasteurization is to insure sufficient heat to destroy the pathogenic organisms and a satisfactory percentage of the total bacteria in all portions of the milk without overheating any part of it, so that a small volume of milk insufficiently heated may not recontaminate the whole lot when distributed through it. The present paper presents the results obtained in a study of the uniformity of heating with the final package method of pasteurization as carried out in the market milk room of the Iowa State College on the "special" milk put out on the milk route.

METHODS USED

The method of final package pasteurization employed with the milk studied consists of immersing the bottles sealed with metal caps in cases 3 tiers high in a vat of water at a temperature not above 110°F. The temperature of the water is then rapidly increased by means of a steam heater placed along one side and under an iron grate on which the cases rest. When the temperature of the water reaches about 148°F. the steam is shut off and is turned on again only if it is necessary in order to bring the temperature of the milk (which is determined with a bottle thermometer) to 140°F. or to maintain it at at least this temperature during the holding period. In many instances, under these circumstances, the temperature of the milk rises slightly above

140°F. as is evident from the data later presented. After the heating period, the water in the vat is cooled by a spray of cold water entering through a perforated pipe underneath the grate; when the milk is cooled to about 70°F., the cases are removed to the refrigerator and iced.

The milk studied was pasteurized in regular runs made with the apparatus described above but sterilized bottles and caps were used. As soon as the cooling with water was completed, the bottles to be studied were packed in ice and brought to the laboratory where the tests were begun as soon as possible.

The medium used for the determination of the number of bacteria was a beef extract agar and the plates were incubated at 37°C. for forty-eight hours before counting. In all but a very few instances where one of the plates was lost, the results represent the average of two plates.

The creaming ability was determined by the method used previously in the dairy section of the Iowa Agricultural Experiment Station. It consists of putting a nine inch layer of milk in a Nessler tube by filling the tube up to a line filed on it, standing the tube in ice water for about twenty-four hours and then measuring the depth of the cream layer and expressing the result in sixteenths of an inch.¹ In the tests of the creaming ability of the pasteurized milk usually only one determination was made from each bottle, while with the raw milk, as a rule, four tests were made, one from each of four bottles representing the raw milk, and the average taken.

RESULTS OBTAINED

Data showing the importance of uniform heating

In order to illustrate the necessity of considering the uniformity of heating with the final package method of pasteurization, some of the results secured with one of the newer methods devised for the heating of bottled milk are presented in table 1. In the

¹ See Iowa Agr. Expt. Sta. Res. Bulletin no. 31.

TABLE 1
Variations in bacterial content and creaming ability in bottles of milk pasteurized in the same run by one of the final package methods

	RUN 1		RUN 2		RUN 3		RUN 4		RUN 5		RUN 6		RUN 7	
	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer
Raw milk.....	131,000	25.5	900,000	23.5	1,800,000	23.0	13,000	24.5	13,750	24.0	158,500	18.5	533,000	25.0
Bottle 1, Past. milk.....	570	18.0	5,400	15.5	180	14.0	650	21.5	15	10.0	45	9.0	55	18.5
Bottle 2, Past. milk.....	800	17.0	3,500	12.0	160	14.0	110	10.0	40	12.0	25	8.5	640	18.5
Bottle 3, Past. milk.....	950	17.5	190	9.0	50	Indistinct	50	9.5	15	11.0	30	7.0	430	17.0
Bottle 4, Past. milk.....	2,005	25.0	35,000	19.5	105	19.5	580	21.5	65	16.0	50	8.5	890	20.0
Bottle 5, Past. milk.....	2,115	21.0	24,000	22.5	455	18.0	620	21.5	80	21.5	55	13.0	1,120	21.0
Bottle 6, Past. milk.....	1,110	22.0	2,650	21.0	200	14.0	55	14.5	70	19.5	35	10.5	1,040	19.0
Bottle 7, Past. milk.....	3,115	24.5	60,000	22.0	440	22.0	690	21.0	175	22.0	110	12.0	1,295	21.0
Bottle 8, Past. milk.....	4,500	24.5	18,000	21.0	390	18.5	390	21.5	145	22.0	405	16.5	2,060	22.5
Bottle 9, Past. milk.....	3,460	24.0	19,000	22.0	380	20.5	60	16.0	75	17.0	55	12.0	940	21.0

apparatus² used the bottles were pasteurized in the cases which were piled three deep; bottles 1, 2, and 3 were from the top case, bottles 4, 5, and 6 were from the middle case and bottles 7, 8 and 9 were from the bottom case.

From table 1 it is evident that, with the method employed, wide variations existed in the bacterial content and creaming ability of the different bottles of milk pasteurized in the same run. As would be expected there is a general relationship between the effect on the bacterial content and the effect on the creaming ability, a low bacterial content usually accompanying a shallow cream layer. This relationship is by no means always close, however, in the data presented, and is presumably due, in part at least, to the unavoidable errors made in the determination of the numbers of bacteria; the errors made in the determination of the creaming ability are not large if the agreement of duplicate determinations is accepted as a basis for judging accuracy. The data illustrate clearly that, with the apparatus used, big differences would occur in the cream layers on bottles of milk pasteurized in the same run, which would of course be very undesirable from a commercial standpoint, and that considerable differences in the bacterial content of the bottles, with the possibility of incomplete destruction of pathogens in some, might occur.

Data secured on the final package method used at the Iowa State College

The data secured on the method of final package pasteurization employed in the market milk room of the Iowa State College have been divided into two parts on the basis of the number of bottles examined from each run.

The results obtained on ten runs in which one bottle was examined from each of the top, middle and bottom tiers are presented in table 2; the exposure used, as determined by a bottle thermometer in one of the bottles held near the top, is also shown.

² The method will not be described in detail since the results were secured on a small experimental pasteurizer; while there is no reason to believe that different results will be obtained with a larger machine, it seems best to withhold complete information until the method has been tried on a larger scale.

TABLE 2
Variations in bacterial content and creaming ability in bottles of milk pasteurized in the same run by the final package method when the cases are immersed in a vat of water

RUN NO.	RAW		BOTTLE FROM TOP TIER		BOTTLE FROM MIDDLE TIER		BOTTLE FROM BOTTOM TIER		EXPOSURE AS DETERMINED BY BOTTLE THERMOMETER IN A BOTTLE NEAR THE SURFACE
	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	Bacteria per cubic centimeter	Cream layer	
1	45,000	21.5	5	19.0	5	19.0	35	19.0	140°-143°F. for 25 minutes.
2			1,420	18.5	280	18.0	240	18.0	140°-143°F. for 25 minutes.
3	13,750	24.0	30	20.0	40	20.5	65	21.0	142°F. for 20 minutes.
4	158,500	18.5	70	16.5	205	16.5	300	17.0	142°F. for 20 minutes.
5	108,000	20.0	10	20.0	15	20.0	35	20.0	140°F. for 20 minutes.
6	540,000		7,200	18.0	8,400	19.0	9,000	19.5	140°-141°F. for 20 minutes.
7	8,400,000	31.0	15,000	19.0	16,800	19.0	18,000	21.0	140°-142°F. for 20 minutes.
8	323,000	25.0	705	20.5	2,065	21.0	1,700	21.0	140°-143°F. for 20 minutes.
9	135,500	25.5	420	24.0	360	24.0	360	24.0	140°F. for 20 minutes.
10	14,400,000	19.0	10,000	12.0	12,000	12.0	13,000	12.5	140°-142°F. for 20 minutes.
Total			34,860	188.0	40,170	189.0	42,735	193.0	

Results of bacterial counts

The bacterial counts secured on the bottles from a given run show considerable uniformity but it is evident that in general, although by no means constantly, the lowest count was secured on the bottle from the top tier of cases and the highest count on the bottle from the bottom tier. The greatest variation from this general relationship occurred in run 2 where the count on the bottle from the top tier is considerably higher on the percentage basis than the counts secured on the other bottles; runs 8 and 9 also show variations from the general relationship but here the differences are so small that they may easily be due to experimental error. The sums of the three columns showing the bacterial counts after pasteurization can be used to show the general relationship. The sum of the counts secured on the bottles from the top tier is 34,860, that of the counts secured on the bottles from the middle tier is 40,170 and that of the counts secured on the bottles from the bottom tier is 42,735; as would be expected the same relationship is shown here as is shown in the majority of the runs.

Results of creaming ability tests

The data secured on the cream layers show that there was a great deal of uniformity in the creaming ability of the three bottles examined from each run; the differences were entirely too small to have been noticeable if the milk had been allowed to cream in the bottles. In three runs (nos. 1, 5, and 9), the values for the cream layers are the same for the three bottles in each run. Since the differences in the creaming ability of the three bottles in each run are so small, the general relationship can best be seen by comparing the sum of the cream layers of the bottles from the top tier with the sums for the bottles from the middle tier and the bottles from the bottom tier. The values are 188.0 for the bottles from the top tier, 189.0 for the bottles from the middle tier and 193.0 for the bottles from the bottom tier; these sums show that in general there was the shallowest cream layers in the bottles from the top tier, while the deepest cream layers were in the bottles

from the lowest tier. As already stated, however, the variations are entirely too small to be of any significance.

Both the bacterial counts and the cream layers indicate that the heating near the surface of the vat is slightly greater than at the bottom. If the data for each run are considered, it is evident that there is a general agreement between a lower bacterial count and a shallower cream layer, although variations from the general relationship are common; these variations are to be expected where the differences between both the bacterial counts and the cream layers secured on a given run are so small.

From table 2 it is evident that the exposures used decreased the creaming ability of the milk although in the most of the runs the decrease was not very serious. The ten runs also show that higher counts after pasteurization were secured with the milk having the higher initial count.

The results obtained on nineteen additional runs (nos. 11-29 inclusive) in which two bottles from different cases in the same tier were examined, are shown in table 3. The pasteurization exposures were not recorded but were essentially the same as those recorded in table 2.

Results of bacterial counts

As a rule, the bacterial counts secured on the 6 bottles from a given run show a reasonable agreement. However, considerable differences on the percentage basis between bottles from the same tier did occur and in a few instances (e.g., run 17) big variations were encountered. When bottles from different tiers are considered, the variations between counts are greater than when the bottles from the same tier are considered. The general trend of the results can best be seen by considering the sums of the bacterial counts on the heated milk in each column in table 3; the 19 counts on bottle 1, top tier, total 70,935; those on bottle 2, top tier, total 74,365; those on bottle 1, middle tier, total 86,555; those on bottle 2, middle tier, total 82,655; those on bottle 1, bottom tier, total 109,120 and those on bottle 2, bottom tier, total 88,650. The two lowest totals are those for the top tier

TABLE 3
Variations in bacterial content and creaming ability in bottles of milk pasteurized in the same run by the final package method when the cases are immersed in a vat of water

RUN NO.	RAW	BOTTLES FROM TOP TIER				BOTTLES FROM MIDDLE TIER				BOTTLES FROM BOTTOM TIER				
		Bottle 1		Bottle 2		Bottle 1		Bottle 2		Bottle 1		Bottle 2		
		Bacteria per cubic centi-meter	Cream layer	Bacteria per cubic centi-meter	Cream layer	Bacteria per cubic centi-meter	Cream layer	Bacteria per cubic centi-meter	Cream layer	Bacteria per cubic centi-meter	Cream layer	Bacteria per cubic centi-meter	Cream layer	
11	2,400,000	23.0	20,000	16.5	17,000	16.0	850	17.5	1,000	17.0	10,700	20.0	5,050	20.5
12	9,600,000		12,650	22.5	10,100	20.5	34,500	29.0	25,300	28.5	45,500	31.0	40,000	30.0
13	185,000	22.0	275	19.5	190	19.0	220	20.0	375	20.0	450	20.5	335	20.5
14	53,500	22.0	345	16.0	240	15.0	630	17.5	795	16.5	1,120	18.0	870	17.5
15	19,300	21.5	40	14.0	35	14.0	60	16.5	40	16.5	100	17.5	55	17.0
16	945,000		11,500	17.5	9,600	18.0	8,500	18.0	10,500	16.5	17,000	17.5	12,200	17.0
17	4,130,000	21.5	15,700	20.0	24,400	19.0	23,350	20.0	31,600	20.0	18,500	20.0	13,000	20.5
18	410,000	23.0	150	16.5	245	16.0	325	19.5	400	20.0	440	20.5	455	21.5
19	7,500	26.0	160	22.0	425	20.5	170	22.0	105	22.0	195	21.5	260	21.5
20	6,550*	20.5	200	21.5	70	21.0	195	21.5	85	20.5	265	21.5	200	21.5
21	61,000	18.0	30	14.5	50	14.5	55	15.0	125	16.0	55	14.5	50	15.0
22	1,200,000	19.0	5,960	13.5	6,480	13.0	12,600	15.0	8,320	15.0	9,140	16.0	9,840	16.0
23	375,000		390	17.0	275	16.5	300	17.5	320	17.5	320	17.0	370	17.5
24	102,500*		220	13.5	175	11.5	780	14.0	935	13.0	1,665	13.5	1,965	12.5
25	12,550	20.0	65	15.0	135	16.0	125	17.0	75	16.0	130	17.0	80	15.5
26	14,000		250	16.0	320	14.5	220	17.0	270	16.0	230	18.0	335	18.0
27	88,500*	23.5	2,335	20.5	3,985	21.5	2,830	20.5	1,740	21.0	2,530	21.5	2,655	21.5
28	179,875*		570	21.0	565	20.5	775	22.0	610	22.0	680	23.5	875	23.5
29	7,963*	24.0	95	17.5	75	15.0	70	18.0	60	19.5	100	19.5	55	21.0
Totals			70,935	334.5	74,365	322.0	86,555	357.5	82,655	353.5	109,120	368.5	88,650	368.0

* Average of four determinations.

while the two highest are those for the bottom tier and the general relationship shown is accordingly the same as that shown by the data presented in table 2. The differences in the bacterial counts secured on the bottles pasteurized in the same run are comparatively small, however, and suggest that the variations in the extent of the heating must be quite small.

Results of creaming ability tests

The data secured on the cream layers show only very small differences when bottles from the same tier are considered. When different tiers from the same run are considered the variations were considerably more, and in general the shallowest cream layers were secured from bottles coming from the top tier and the deepest cream layers from bottles coming from the bottom tier. The sums of the cream layers in each column show the general trend of the results. The sum for bottle 1, top tier, is 334.5; that for bottle 2, top tier, is 322.0; that for bottle 1, middle tier, is 357.5; that for bottle 2, middle tier, is 353.5; that for bottle 1, bottom tier, is 368.5 while that for bottle 2, bottom tier is 368.0. These sums show a very good agreement between bottles 1 and 2 of each tier and in general show a slight increase in the depth of the cream layer with an increase in the distance from the surface of the vat. The differences in the cream layers secured on bottles from a given run indicate, however, that in general the heating must be fairly uniform.

The results for run 12 show an unusual situation in that the differences between the cream layers secured on the different tiers are much greater than is usually the case and accompanying this are differences in the bacterial counts secured on the different tiers that are greater than in any other run. This indicates a reasonably close agreement between the effect on the creaming ability and the effect on the bacterial count. This same relationship is shown in other instances but not as definitely as in run 12.

The agreement of counts made on the same milk

In order to get definite information as to the variations in the bacterial counts that could be attributed to experimental error under the conditions prevailing, counts were run on four bottles of the raw milk in each of five of the runs dealt with in table 3. The results of the counts are given in table 4 as is also the average of each set and the per cent variation of each count from the average.

From table 4, it will be seen that in run 20 the variations ranged from 2 to 18 per cent with 3 counts less than the average

TABLE 4

Variations in the bacterial counts secured on bottles of the same lots of raw milk

	RUN 20		RUN 24		RUN 27		RUN 28		RUN 29	
	Bacterial counts	Per cent variation from average	Bacterial counts	Per cent variation from average	Bacterial counts	Per cent variation from average	Bacterial counts	Per cent variation from average	Bacterial counts	Per cent variation from average
Average.....	6,550		102,500		88,500		179,875		7,963	
Determination 1..	7,700	+18	93,500	- 9	81,500	- 8	192,500	+7	7,450	-6
Determination 2..	6,450	- 2	104,000	+ 1	96,500	+ 9	168,000	-7	8,700	+9
Determination 3..	5,900	-10	101,500	- 1	100,000	+13	181,000	+1	8,450	+6
Determination 4..	6,150	- 6	111,000	+ 8	76,000	-14	178,000	-1	7,250	-9

and 1 above; in run 24 the range in the variations was from 1 to 9 per cent with 2 above and 2 below the average; run 27 showed variations from 8 to 14 per cent with 2 above the average and 2 below; run 28 showed variations from 1 to 7 per cent with 2 above the average and 2 below, and in run 29 the variations ranged from 6 to 9 per cent with 2 above the average and 2 below the average. The count showing the greatest variation from the average showed a variation of 18 per cent. From the results presented it seems certain that the differences shown in tables 1, 2, and 3 in the bacterial counts secured on bottles from the same run represent real differences and cannot be ascribed to experimental error.

General consideration of the results

The results secured and presented in tables 2 and 3 indicate that, with the method of final package pasteurization under consideration, the different bottles pasteurized in a given run are heated quite uniformly and that, with this method, the variations in the heating are in general of no importance from the standpoint of the bacterial counts or the creaming abilities. The data secured suggest that there is a tendency for the bottles at the top of the vat to be heated the most and those at the bottom to be heated the least; this tendency is shown in both the slightly lower bacterial counts and the slightly shallower cream layers in the bottles of milk held nearest the surface. The differences between the bottles at the surface and those at the bottom is not at all a constant one and in some cases the differences are considerable; these differences may be influenced by the rate of heating the water or by some other such factor. The cause for the greater heating at the surface is presumably the tendency of the heated water to rise and thus to heat the surface bottles more than those beneath.

From the data presented it seems that there is ordinarily a small variation in both the bacterial content and the creaming ability of bottles of milk pasteurized in the same tier, but these variations are too small to be of any significance from a practical standpoint. They may be due in part to differences in the thickness of the bottle wall which would, of course, affect the rate of heat transmission from the surrounding water to the contained milk.

The reasonably close agreement between the effect of heat on the bacterial count and on the creaming ability as shown throughout tables 1, 2, and 3 suggests that tests of the creaming ability afford a satisfactory and simple method of determining the uniformity of heating in the final package method of pasteurization. By determining the cream layer thrown up by a number of bottles of milk pasteurized in a given run the uniformity or lack of uniformity in heating can quite readily be told. The determination of the cream layer is much less time consuming

than the determination of the number of bacteria present, less apparatus is required, and the results are more quickly secured. Furthermore, creaming ability tests can be used under the conditions prevailing in small plants where bacterial counts can usually be made only with extreme difficulty. The creaming ability should be determined by means of tubes such as Nessler tubes rather than by allowing the bottles of milk to stand, since slight differences in the creaming ability can be much more readily detected by the use of tubes.

Significance of uniform heating with the final package method of pasteurization

With the method of final package pasteurization, the uniform heating of the milk assumes a somewhat different significance than with the usual holding or continuous methods. An insufficiently heated bottle may be a source of great danger and this is particularly serious because of the rather widespread belief that milk pasteurized by the final package method is certainly safe since there is no opportunity for contamination after the heating, and since the heating is supposed to destroy all the pathogens ordinarily present. On the other hand, however, one or more improperly heated bottles will not contaminate the entire run of milk as will a small portion of insufficiently heated milk with other methods of pasteurization. Where the milk of a given run is not mixed after heating as is the case with the final package method, there is no equalization of the creaming ability and of the heated flavor and as a result where there is a lack of uniformity in heating, big differences in the extent of the heated flavors and in the cream layers developed are observed. The problems of heated flavor and creaming ability accordingly assume a much greater importance, from the standpoint of the uniform heating of the milk, with the final package method than with the other methods of pasteurization and may be of a great deal of significance under commercial conditions.

CONCLUSIONS

1. The problem of the uniform heating of the milk is deserving of careful consideration with the final package method of pasteurization as well as with the other methods.

2. Great variations occurred in the extent of the heating of different bottles in the same run with a small experimental final package pasteurizer.

3. With the method of final package pasteurization in use at the Iowa State College Market Milk Room which consists of heating in a vat of water, only small variations occurred in the bacterial content and the creaming ability of different bottles from the same run. There was, however, a general tendency for the bottles at the surface to show the lowest bacterial content and creaming ability; the differences in general were, however, too small to be of practical significance.

4. The determination of the creaming ability by means of tubes of milk allowed to stand affords a simpler and quicker method of detecting the uniformity or lack of uniformity in heating with the final package method than does the determination of the bacterial counts.

THE POSSIBILITY OF INCREASING MILK AND BUTTERFAT PRODUCTION BY THE ADMINISTRATION OF DRUGS¹

ANDREW C. McCANDLISH

Dairy Husbandry Section, Iowa Station, Ames, Iowa

The secretion of milk, being an extremely complicated process, is subject to many variations and though some of the factors influencing it are understood, many others are unappreciated or even unknown. For a long time it has been believed that many drugs have the power of influencing milk secretion and, owing to the popularity of official and semi-official testing of dairy cows, this is of special interest at the present time.

Within recent years some men undoubtedly have tried to influence favorably the production of their test cows by means of drugs and consequently when a cow makes an exceptional record there are many ready to affirm that drugs must have been used to bring about the phenomenal results. Consequently some breed associations prohibit the use of such substances with cows on test and it is not uncommon for association officials to make public denial of the use of drugs in connection with the making of certain records.

The present work was undertaken, with the coöperation of Dr. H. D. Bergman, of the Department of Physiology and Pharmacology, of the Veterinary Division of the Iowa State College, to test the validity of some of these statements regarding the use of drugs with milk-producing cows.

The knowledge of the effect of drugs on the active mammary gland is very incomplete and, though admitting the fact that drugs might under certain circumstances alter milk secretion, the veterinary profession does not recognize any direct galactagogues.

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No attention will be given here to experimentation with the human subject, the goat, or mammalia other than the cow, for the simple reason that though much valuable work has been done with these subjects the results need not necessarily be directly applicable to the cow as there may be certain generic differences in physiological activity, and it is known that in some cases, e.g., with the human subject, variations in milk production can be brought about much more readily than in the case of the cow.

✓ There are various ways in which the activity of the udder might be influenced by drug action and amongst these are the following:

- ✓ 1. Direct action of the drug on the protoplasm of the secretory cells.
- ✓ 2. Influencing the secretory nerve terminations.
- ✓ 3. Vasomotor influences with a resulting change in the amount of blood supplied to the active mammary tissue.
- ✓ 4. Variation in the heart's action with a possible influence on circulatory conditions.
- ✓ 5. Action on the digestive system, thus influencing the amount of nutrients available for utilization by the secretory cells.

As these actions may be brought about separately or in almost any combination and in varying degrees of intensity, it is seen that the problem of the influence of drugs on milk secretion is a complicated one and the fact that individual cows may vary somewhat in degree of susceptibility to drug action increases the complexity.

The problem is here treated with the view of determining the possibility of influencing the production of healthy cows and more particularly the percentage of fat in the milk, and thus ultimately the total yield of fat. In conducting this work the one or two day tests of the dairy cattle breed associations were kept in mind because it is not only in such tests that there would be the greatest opportunity and temptation to use drugs, but also fairly well recognized that a slight increase in production might be maintained for a few days by the use of drugs and yet be only temporary; and in addition continued drug administration would be more readily detected.

There is a long list of substances popularly reputed to have galactagogic effects—amongst these are the aromatics, fennel, anise, caraway, juniper berries, coriander, dill, pimpinella, calamus; the bitter stomachics, sulphur, the neutral salts, the antimony preparations, and many others—but distinction must be made between the use of drugs based on a knowledge of their physiological action and the use of those indicated by empirical teachings. The popular milk powders are compounded largely from the constituents just stated.

In this piece of work the drugs used include alcohol, castor oil, pituitrin, pilocarpine, physostigmine, aloes, calomel, nux vomica, Epsom salts and common salt, and these have been chosen in view of the fact that a knowledge of their physiological action would seem to indicate some possibility of their either directly or indirectly influencing the mammary gland. Some of the principal physiological effects noted upon the administration of these drugs are as follows:

Alcohol. When introduced into the general circulation alcohol produces a narcotic effect especially on the nervous tissues. It diminishes the efficiency of vital organs like the heart, blood-vessels and blood and their nervous mechanisms, with, in certain cases, an initial but transient stimulation. It interferes with body metabolism and especially with body oxidation. In addition, alcohol removes water from the tissues in large quantities, producing diuresis. This abstraction of water creates a physiological thirst which may result in a great craving for water or it may induce nausea with a consequent distaste for water.

Castor oil. Castor oil is not absorbed from the intestinal tract and in itself is not purgative. It is broken down in the alimentary canal with the production of ricinoleic acid and other substances which cause great irritation and subsequently bring about purging which not only carries off nutrients that might otherwise be utilized but also produces general depression.

Pituitrin. The extract of the pituitary body, one of the ductless glands, brings about a rise in blood pressure probably due to vaso-constriction and simultaneous heart stimulation though it has been found that the heart may not always be stimulated and

sometimes may even be weakened. It brings about an increase in urine elimination, perhaps by direct action on the renal epithelium, and it also stimulates the uterus and bladder.

Pilocarpine. The terminations of what are pharmacologically known as the autonomous nerves—the nerves serving the involuntary muscles but not passing through the sympathetic system—are stimulated by pilocarpine and consequently its administration may result in slowing of the heart, constriction of the bronchi, increased peristalsis, and hyper-secretion of the gastric, intestinal, salivary and sweat glands.

Physostigmine. Eserine or physostigmine acts very similarly to pilocarpine with the exception that it does not influence the secretions as markedly but stimulates peristalsis to a greater extent.

Aloes. The purgative action of aloes is due to the active principle aloin which stimulates peristalsis of the large intestine but does not influence the intestinal secretions. It is absorbed from the large intestine and is eliminated by way of the bowels, kidneys, and mammary gland. It sometimes causes diuresis; induces reflex irritation of the female pelvic organs, is an emmenagogue; and may be abortifacient.

Calomel. This is changed in the intestine to the grey oxide of mercury which has an irritating effect and so produces purging. Its action is chiefly on the small intestine and it is not absorbed. It is supposed to be a cholagogue, the fact that it flushes out the small intestine probably inducing the bile to follow along though there is no direct action on the liver. Mercury, being a local irritant, may lead to increased secretion of the glands if the dose is sufficient to irritate without destroying the glandular protoplasm.

Nux vomica. When taken internally nux vomica, being a bitter stomachic, increases appetite and stimulates the secretion of the digestive juices. Therapeutic doses, after absorption, stimulate the great medullary centers, respiratory, vasomotor, and cardio-inhibitory, with a consequent rise in blood pressure and slowing of the heart. It is frequently given as a "tonic" but its only influence on nutrition is to send more blood to the tissues.

Epsom salts. The purgative action of magnesium sulphate is due to the fact that it not only prevents the absorption of water from the intestine but also abstracts water from the intestinal wall into the lumen.

Common salt. Sodium chloride is absorbed and does not cause purging, except when in large quantities, though it produces diuresis by abstracting water from the tissues.

PREVIOUS WORK

The study of the action of galactagogues on the human subject, goats and small laboratory animals has been fairly extensive, while their influence on the milk production of cows has received little attention.

Pituitrin. Even in the case of pituitrin, the most studied of all supposed galactagogues, very little work has been done with bovines. In endeavoring to find if there were any commercial benefits to be derived from treating cows with pituitrin, Gavin (1) used three methods for administering pituitary extract—by the mouth, subcutaneously, and intravenously—and he came to the conclusion that no increase in the daily milk yield or in the percentage of fat in the milk was obtained as a result of pituitrin administration. Hill and Simpson (2), on the other hand, found that the percentage of fat in cow's milk could be increased by administering pituitary extract intravenously but the yield of fat subsequently made a compensatory decrease.

Pilocarpine and physostigmine. According to Feser (3) the milk yield of cows is slightly increased by the injection of pilocarpine and eserine, while Frohner (4) got negative results with pilocarpine.

Aloes. It was found by Lanzoni (5) that the fat percentage in cow's milk was decreased by the administration of aloes.

Epsom salts. Lanzoni (5) found that the fat in cow's milk was increased after the administration of magnesium sulphate.

PLAN OF EXPERIMENT

The experimental work on which this paper is based was conducted in two parts, the preliminary series of experiments being carried out with only one cow, while in the second series three cows were used.

TABLE I
Animals used

	SERIES			
	I	II		
Cow number.....	262	207	243	262
Breed.....	Grade Guernsey	Grade Holstein	Ayrshire	Grade Guernsey
Age, years.....	2.0	4.2	3.1	2.7
Weight, pounds.....	800	1280	840	900
Fresh, days.....	10	86	155	242
Previous lactations.....	0	2	0	0

The animals were all young, in good milking condition and free from derangements of health. They were kept open throughout the experiments.

The rations fed were practical ones suited to the needs of the animals and were such that no appreciable changes in the live weights of the animals took place.

In the first series the experimental periods were not always of the same length but in the second series the experimental periods were always of two days duration, while the check periods were each of four or five days. The experimental period was always taken as beginning with the milking next following the administration of the drug, the influence of which was being studied, and there were check periods before and after each experimental period.

The drugs were given either orally or subcutaneously.

TABLE 2
Administration of drugs

DRUG	SERIES	DOSAGE AND METHOD OF ADMINISTRATION
Alcohol.....	I.	3 ounces of grain alcohol in a quart of water twice daily for two days
	II	Dose increased to 4 ounces
Castor oil.....	II	16 ounces in evening and 8 ounces in morning daily for two days
Pituitrin.....	I	2 drams of pituitary extract subcutaneously twice daily for four days
	II	Pituitary extract subcutaneously in doses of 1 dram in evening, 1 dram in morning and 2 drams at noon daily for two days
Pilocarpine and physostigmine....	I	2 subcutaneous injections $\frac{1}{2}$ hour apart in the morning and the same in the evening, daily for four days. Each dose contained 1 grain pilocarpine hydrochloride and $\frac{1}{2}$ grain physostigmine benzoate
	II	2 grains pilocarpine hydrochloride and $\frac{1}{2}$ grain physostigmine benzoate hypodermically three times daily for two days
Aloes.....	I	1 bolus containing 240 grains aloin, 60 grains calomel, and $\frac{1}{2}$ dram fluid extract of nux vomica; given in 1 quart of water
	II	Cows 207 and 243 each received 1 ounce aloes in a quart of water in the evening, while 262 was given 6 drams each evening on two consecutive days
Magnesium sulphate, sodium chloride and nux vomica	II	Each cow given twice daily for two days the following in a quart of water—8 ounces magnesium sulphate, 4 ounces sodium chloride, $1\frac{1}{2}$ drams powdered nux vomica

RESULTS

The results from the two series of trials will be considered together though tabulated separately.

TABLE 3

Average daily yields for cow 262 in first series of trials

DRUG	PERIOD	MILK	FAT	FAT
		pounds	per cent	pounds
Alcohol.....	Check	19.2	3.83	0.74
	Experiment	18.3	3.95	0.73
Pituitrin.....	Check	20.2	3.67	0.74
	Experiment	18.1	3.59	0.65
Pilocarpine and physostigmine.....	Check	19.4	3.64	0.71
	Experiment	19.2	3.99	0.77
Aloin, calomel and nux vomica.....	Check	19.4	4.01	0.78
	Experiment	15.9	4.80	0.76

In the trials of the first series with alcohol and aloin all periods were of four days each while in the other two trials the periods were of two days each.

On the whole the use of alcohol depressed rather than stimulated milk and butterfat production. The cow used in both experiments was remarkably uniform in her response to the drug. In all cases there was a slight decrease in total fat yield; and though there was a slight increase in fat percentage in all but one case, the single decrease that did occur was large enough to bring the average down to normal.

As the castor oil administered did not in any case induce purging or even a noticeable laxativeness it may be presumed that the cows were not overdosed, yet in every case there was a decrease in the percentage of fat in the milk and in some cases this was very marked even though the changes in milk yield were hardly appreciable. The total yield of fat also decreased in each case—on one occasion markedly. On the average there was no change in the milk yield but a decrease of about 10 per cent in the percentage and total yield of fat.

The cow used in both series of trials showed a decrease in milk production on both the occasions on which she was treated with pituitrin, while the other animals showed very slight changes

TABLE 4
Average daily yields for cows 207, 243, and 262 in second series of trials

DRUG	PERIOD	COW									AVERAGE		
		207			243			262			Milk	Fat	Fat
		Milk	Fat	Fat	Milk	Fat	Fat	Milk	Fat	Fat	pounds	per cent	pounds
Alcohol.....	Check	18.6	4.71	0.88	16.7	4.30	0.72	15.5	4.56	0.71	16.9	4.53	0.77
	Experiment	17.6	4.26	0.75	16.6	4.49	0.75	14.8	4.71	0.70	16.3	4.47	0.73
Castor oil.....	Check	18.3	4.57	0.84	17.8	3.95	0.70	16.4	4.10	0.67	17.5	4.21	0.74
	Experiment	17.7	3.76	0.67	18.2	3.65	0.67	16.5	3.97	0.66	17.5	3.79	0.66
Pituitrin.....	Check	16.7	4.98	0.83	17.6	4.55	0.80	16.7	4.44	0.74	17.0	4.65	0.79
	Experiment	17.1	3.63	0.62	17.9	3.89	0.70	15.5	3.74	0.58	16.8	3.76	0.63
Pilocarpine and physostigmine.....	Check	18.7	4.63	0.86	18.6	3.78	0.70	16.3	4.06	0.66	17.8	4.16	0.74
	Experiment	17.4	4.51	0.79	19.0	4.00	0.76	16.3	4.26	0.70	17.6	4.25	0.75
Aloes.....	Check	18.5	4.46	0.83	15.7	4.11	0.65	14.8	4.36	0.65	16.4	4.32	0.71
	Experiment	18.4	4.77	0.88	15.5	4.13	0.64	14.7	4.54	0.67	16.2	4.49	0.73
Magnesium sulphate sodium chloride and nuxvomica	Check	18.8	4.79	0.90	18.0	4.15	0.75	16.0	4.31	0.69	17.6	4.42	0.78
	Experiment	18.4	4.58	0.84	18.0	4.33	0.78	14.6	4.50	0.66	17.0	4.47	0.76

In the trials of the second series all experimental periods were of two days duration, the check periods for alcohol, castor oil and aloes were of four days each, and all other check periods were of five days each.

in milk yield. In every case there was a marked decrease in total yield of fat and throughout the second series of trials the administering of pituitrin resulted in a marked decrease of the percentage of fat in the milk. The average for the second series showed no appreciable change in milk yield but a decrease of about 20 per cent in percentage and yield of fat.

In the first series there was an appreciable increase in fat percentage and yield of fat when pilocarpine and physostigmine were administered and the cow used in this trial behaved very similarly in the second trial. One of the other cows in the second

TABLE 5

Percentage changes in production for first series of trials

DRUG	PER CENT CHANGE	MILK	FAT	FAT
		<i>pounds</i>	<i>per cent</i>	<i>pounds</i>
Alcohol.....	Increase		3	
	Decrease	5		1
Pituitrin.....	Increase			
	Decrease	10	2	12
Pilocarpine and physostigmine.....	Increase		10	9
	Decrease	1		
Aloin, calomel and nux vomica.....	Increase		20	
	Decrease	18		3

trial showed an increase throughout very similar to that shown by the cow used in both trials while the remaining animals showed a decrease in milk-yield and percentage and yield of fat. On the average the second series showed no appreciable changes.

The administration of aloes in no case produced purging. In the first series the aloes ball (containing aloin, calomel and nux vomica) induced a phenomenal decrease in milk production with a correspondingly high percentage of fat and on the whole the yield of fat was slightly reduced. In the second series there were no marked changes when the average yields were considered and even the individual variations were comparatively slight.

TABLE 6
Percentage changes in production for second series of trials

DRUG	PER CENT CHANGE	COW												AVERAGE		
		207						243						262		
		Milk	Fat	Fat	Milk	Fat	Fat	Milk	Fat	Fat	Milk	Fat	Fat	Milk	Fat	
		pounds per cent	pounds	pounds per cent	pounds	pounds per cent	pounds	pounds per cent	pounds	pounds per cent	pounds	pounds per cent	pounds	pounds per cent	pounds	
Alcohol.....	{ Increase Decrease	5	10	15		4	1		4	3	1	4	1	5		
Castor oil.....	{ Increase Decrease	3	18	20		8	2		4	1	3	1	10	11		
Pituitrin.....	{ Increase Decrease	2	27	25		15	2		13	7	16	22	1	19	20	
Pilocarpine and physostig- mine.....	{ Increase Decrease	7	3	8		6	2		9	5	6	1	2	1		
Aloes.....	{ Increase Decrease	1	7	6			1		2	1	4	3	1	4	3	
Magnesium sulphate sodium chloride, and nox vumica...	{ Increase Decrease	2	4	7		4			4	9	5	4	3	1	3	

The mixture of epsom salts, common salt and nux vomica given was accompanied by only slight changes in milk and butterfat yield.

RÉSUMÉ

1. The action of galactagogues on the production of cows has received little experimental study.

2. The results obtained from the use of galactagogues with dairy cattle and even laboratory animals are very conflicting.

3. The drugs used in the present study could not be relied on to induce an increase in the production of milk or in the yield or percentage of butterfat.

4. The most noted changes were decreases in the yield and percentage of butterfat brought about by pituitrin and castor oil.

5. Wide individual variations in their response to the drugs were shown by the cows.

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IMPORTANCE OF SALT IN RATIONS

JACOB JOFFE

Rutgers College, New Brunswick, New Jersey

Referring to the importance of salt in the ration, our eminent investigator, Professor Henry, in his book, "Feeds and Feeding," states: "Though little is known from investigations in this subject, it is evident from the extreme fondness of dairy cows for salt that this article should be regularly and abundantly supplied them." Stockmen, dairymen, farmers recognize the importance of a salt supply; the addition of salt to the feed is a common practice. However, very few feeders give this problem its due consideration, especially as to the amounts of salt, the modifications under different circumstances, the form of supply, etc.

The idea of this paper is an attempt to review the literature on this subject, to bring forth the modern views; and, if possible, to draw some practical conclusions. At first we shall look into the history of the subject; then dwell on the physiological functions produced by the intake of salt; take a glance into the experimental data available and finally draw conclusions.

It is unquestionable that at the time our domesticated herbivora grazed the virgin lands in Asia and Europe, they were provided by nature with salt either in proper grasses or from salt beds. It is a known fact that wild ruminants and hoofed animals seek out salt rocks and pools, and places where salt effloresces, to lick the salt. Hunters take advantage of this in tracing their booty. Just when the domesticated animals began to receive salt as such can only be conjectured; we shall not be out of the way, if we assume that the introduction of salt to man marks also the time of its introduction to animals. The habitual use of salt by man is intimately connected with the advance from nomadic state to agricultural. The reason for this will be clear after we look into the physiological side of the question of salt consumption. The rational application of common salt to the feed of animals runs parallel to the development of rational

scientific methods of feeding. This will lead us to the time when feeding standards began to appear. According to Henry, the first feeding standard appeared in 1810 when Thaer published his "hay equivalents." The further development of the supply of salt to the ration in its historical perspective cannot be taken up in detail; this paper is not simply a historical review. It will, however, be taken up again, when we come to review the experiments in this line.

Now we will turn our attention to the physiological aspect of salt intake.

Bunge in his work "Physiologic and Pathologic Chemistry" says: "The question as to the need of inorganic salt by adult animals cannot be considered as settled." "Among the mineral substances contained in the fluids of the animal body common salt comes first in order of quantity" (Tigerstedt). None of the inorganic salts found in the body appear as such in our diet. Common salt forms the only exception which is the more remarkable as our diet is by no means deficient in it. Henry states: "A moderate addition of salt to the fodder increases the activity of the secretions of the body juices, their circulation, and consequently increases the protein consumption in the body. Salt has a stimulating influence on the appetite, facilitates the passage of albuminoids from the digestive canal into the blood and, in general, increases the energy of the vital processes. Another effect of salt is to increase the excretion of urine. If, after supplying salt, the animal is prevented from drinking water, the water which would otherwise pass off through the lungs and skin, will be diverted to the kidneys; and if the supply from this source is not sufficient, water will further be drawn from the body tissues." This will produce a disturbance and in feeding salt it should be taken into consideration. "Salt accelerates digestion of paracasein lime by the action of rennet" (*Zeitschrift Physiologischer Chemie*, 1909, pp. 147-163). "Salt in food facilitates the cleavage of amino acids from peptones" (*Chemische Zentralblatt*, 1909). "Surely in most cases, especially in stable feeding, salt is a very desirable condiment. It is necessary in the formation of digestive juices, it supports the digestion of albumin. It

also keeps in solution the albuminoids in the blood circulation. It is well known that the blood serum of mammals contain about 0.5 per cent of NaCl. We find in the stomach and in some parts of the intestines certain amounts of HCl which may be formed from NaCl" (Flugschriften der Deutschen Landwirtschafts Gesellschaft, Heft 10, 1911).

Common salt under certain conditions exercises poisonous effects. According to Loeb, a pure NaCl solution is poisonous to animals, the poisonous effect being due to the Na ions. The only reason why the effects are not prominent is due to the fact that there are metal proteids of Ca, K, Mg, and Na in the body and the excess of the Ca and K ions annihilate the poisonous effects of the Na ions. In his paper on ion-proteid compounds, Dr. Loeb cites an interesting series of experiments proving the poisonous effects of a pure solution of NaCl and showing that the more concentrated the solution, the more poisonous it is. This naturally has a great bearing upon the amounts of salt fed to animals. If an excess of NaCl is fed, the Na ions take the place of the other metal ions in the ion-proteids of the tissue, and if it is true that life phenomena depend upon the presence of a number of various metal proteids (Na, Ca, K, Mg) in definite proportions, the equilibrium is disturbed. In testing the duration of life of young fundulus in NaCl solution, Loeb records the fact that in a pure NaCl solution the fundulus died after twelve hours. Diluting the solution, he increased the life duration, and in a 100 per cent distilled water, the fundulus lived the longest. This may lead some to think that NaCl is not so important a factor in the life process; moreover the absence of NaCl prolonged the life of the fundulus. In reviewing the literature on the importance of salt in the ration, the writer met a statement of a Dutch veterinarian by the name WestBroek; he says: "The common belief in the necessity of salt in the diet for domestic animals is not well founded." He argues that the addition of salt to the ration causes more or less serious disturbances in the normal osmotic process, at times greatly changing the tissue and fluids of the animal body. Common salt gradually replaces the salts which should be present in animal tissue and causes patho-

logic conditions. This, however, does not warrant the exclusion of salt from the ration since there is a possibility that the normal supply of NaCl in the feed and drink may not be sufficient for the continued balance of the ion-proteids. Bunge, in the above mentioned work, brings out rather interesting data. He says:

The desire for salt is more pronounced in the herbivora and *never* in the carnivora. Herbivora need more salt, for vegetable food contain more K and the latter eliminates Cl and Na through the kidneys.

Country people eat three times as much salt as city people. The Mosaic law commands the Jews to present their vegetable offering accompanied by salt. The hunting tribes of Siberia and northern Russia use no salt. The Kalmyks and Kirgisi of the Steppe near the Caspian Sea who take milk and meat only in their diet use no salt.

In the light of these facts, will become reasonable the statement made in the historical review of the subject: that the habitual use of salt came with the advance from nomadic state to agricultural. In the nomadic state we used mostly meat and were similar to carnivorous animals, that never use any salt. As man settled and began to till the soil he also introduced vegetables in the diet. This change created a condition whereby the amount of NaCl taken in was not enough for the normal metabolism in the body, for vegetables contain considerably less NaCl and more K than meat and, as mentioned above, a high K content causes Cl and Na to be eliminated through the kidneys. From what has been said we may feel justified in concluding that NaCl in most cases is essential for normal body functions. An excess of salt is poisonous; whether an omission of salt will produce pathologic effects depends on conditions. If we are able to feed foodstuffs high in NaCl content and low in K, the omission of salt will have no effect. But such conditions are rare. It is only possible on land near sea where we find a number of grasses that have the power to inhibit more NaCl than under far inland conditions. It may also be possible on soils containing a fair amount of NaCl.

Thus we see that in order to avoid pathologic conditions we have to feed a rational amount of salt. The necessary amount can be

determined through experiments. But before the experimental work is taken up it will be well to look into another phase of the subject. We will analyze the proportions of Na and K in different feedstuffs from data available on hand, and endeavor to find a possible clue to predetermine the variable modifications of salt supply in accordance with the different feedstuffs.

The following tables are taken from Bunge's "Physiologic and Pathologic Chemistry."

Table I shows that hay (especially that low in K_2O) contains both a high Na_2O content and a low K_2O content, a condition

TABLE I

In 1000 parts of dried substances the proportions are:

Arranged according to increasing amounts of K			Arranged according to increasing amounts of Na.		
	K_2O	Na_2O			Na_2O
Rice.....	1	0.03	Rice.....	0.03	
Bullock's blood.....	2	19.0	Apples.....	0.07	
Oats, wheat, rye, barley..	5-6	0.1-0.4	Beans.....	0.13	
Dog's milk.....	5-6	2-3	Clover.....	0.17	
Human milk.....	5-6	1-2	Oats, wheat, rye, barley..	0.1-0.4	
Apples.....	11	0.1	Potatoes.....	0.3	
Peas.....	12	0.2	Hay.....	0.3-1.5	
Milk of herbivora.....	9-17	1-10	Human milk.....	1-2	
Hay.....	6-18	0.3-1.5	Dog's milk.....	2-3	
Beans.....	21	0.1	Milk of herbivora.....	1-10	
Strawberries.....	22	1.2	Bullock's blood.....	19	
Clover.....	23	0.1			
Potatoes.....	20-28	0.3-0.6			

whereby the salt requirements are of little importance. On the other hand, if we examine the concentrates: wheat, rye, oats, and barley, we notice that they are relatively higher in K_2O and lower in Na_2O content than is hay. Here we may find it necessary to supply salt. Common practice tells us that when the cattle are out in the pasture, they consume less salt than when kept in stable and fed concentrates. This bears out our conjecture as to the modifications necessary under different environment. In the case of clover, we can see that a still higher per cent of salt supply would be necessary. Table 2 affords a direct comparison, giving the ratio of Na_2O to K_2O , Na_2O being one.

It will be well to notice that milk of herbivora is in the center of table 1 and first in table 2. Graphically, it represents that milk is the ideal food in respect of salt requirements, and we know that this is true. It seems plausible to the writer that standards of salt requirements may be fixed, taking the milk of the herbivora as the ideal one. It would be highly interesting to conduct a series of experiments in this line. So far as the writer could find out, no work has been attempted for this purpose.

Now we will turn our attention to the experimental work in connection with salt requirements in the dairy ration. Only few experiment stations have attempted to do work of any impor-

TABLE 2

For one equivalent of Na_2O the equivalents of K_2O are:

Milk of herbivora.....	0.8-0.6
Wheat.....	12-23
Barley.....	14-21
Oats.....	15-21
Rice.....	24
Rye.....	9-57
Hay.....	3-57
Potatoes.....	31-42
Peas.....	44-50
Clover.....	90
Apples.....	100
Beans.....	110

tance. Wisconsin, Mississippi, Kansas, and Ontario are in order of importance. This paper will treat the work of the Wisconsin Station, for it summarizes the work of the others. The name of Dr. Babcock, who was connected with the work at Wisconsin, makes it more valuable.

Dr. Babcock reviews the work of other experimenters. Bous-singault in 1847 and later in 1854 conducted experiments to ascertain the effects of salt on the milk flow. In both cases he fed hay, all the cows wanted, for periods from fourteen to twenty-one days without salt, then gave salt at the rate of two ounces per day for a period of sixteen to twenty-seven days. No increase in the milk flow was noticed. Later experiments by Bahr and Wolf showed that although the addition of salt caused an increase

in the weight of the animal, yet it had no effect on the milk yield. It seems to the writer that these experiments cannot prove that a deficiency in salt will not decrease the milk flow. The purpose of the experiments should be to ascertain whether an addition of salt will increase the yield in cases where such is deficient. Bous-singault's experiments were conducted with hay feed, and the latter is usually high in Na_2O and low in K_2O : these are the conditions where no salt is of great importance. In an experiment conducted by Richter in 1855 where the kind of feed is not stated we do find an increase in milk flow: one pound per day. In all probabilities the feed was low in Na_2O , high in K_2O . Professor Robertson from the Ontario Experiment Station had four groups of cows: two groups were fed without salt, the other two had all the salt they wanted. In two days the two non-salt groups fell off 17.5 per cent in their milk flow. He also noticed that, "the milk of the unsalted cows turned sour in twenty-four hours less time than the milk from the salted cows." Experiments conducted by Lane in 1861 showed, that when cows were given 2.5 ounces of salt per day the per cent of solids in the milk was 13 per cent, while when he doubled the quantity of salt, the total solids amounted to only 8 per cent. Here we have a case of the harmful influence of an excess of salt. The Mississippi Station Report of 1888 gives data of an experiment whereby three "salted" cows showed a gain of 110 pounds of milk in two weeks. The amount of salt given was four ounces per day. It is very likely that the feed was very low in Na_2O and high in K_2O . Dr. Babcock conducted two series of experiments: one in 1899, the other ten years later. Both series dwell mainly on the influence of salt on the milk flow. In the first test in 1899 there were two lots of cows, three in each. One lot received salt, the other did not. The experiment covers a period of three months. The salted cows were given 2 ounces a day. After ten days they refused to eat up this amount, and 1 ounce was given; this was eaten up. The production figures apparently do not show any advantage for salt. It is the writer's opinion that no increase should have been looked for. The cows refused to eat up 2 ounces of salt and this phenomenon occurred after the animals had been

turned out on pasture, the latter consisting mainly of blue grass. It would be interesting to find out the Na_2O and K_2O ratio in blue grass. The writer ventures to assume that the blue grass was supplying most of the salt necessary. Dr. Babcock seems to doubt his own conclusions by advising the use of salt, although he tries to show that the addition of salt even decreased the yield.

In test II, conducted ten years later, e.g., in 1899, the same purpose was followed as in 1888. The period of time was prolonged one year; salt was fed to the "salt cows" on alternate months. The reason for the latter was not given. There were two lots, eight cows in each one. Lot I received no salt, lot II received salt on alternate months. In the latter experiment the length of time with no salt in the ration varied. It ranged from two and one-half to fifteen months. After being deprived of salt for three weeks, all of the cows became exceedingly hungry for it. They would lick the mangers, walls of the stable, and hands and clothing of the attendants. Some would eat horse manure; in one instance a cow chewed up a piece of old clothing saturated with perspiration. All of the cows were eager to lick the dust of the car tracks, which had been salted during the winter to remove ice. Shortly after being turned out to pasture, several of the cows began to scour badly, their excrements having the appearance of dried mud. This condition was found to be caused by the consuming of large quantities of salt from a spot in the field where a considerable amount of salt had been deposited a year before. In the case of lot I two cows had to be supplied with salt before their time was up. In both cases the cows became sick and after a supply of salt they recovered. Both cases appeared after calving. Alma, a cow from lot II, which had received no salt for two and one-half months became sick with colic, vomiting large quantities of undigested food. She was given eight ounces of salt in water as a drench; this was followed by one ounce daily and she recovered. Goodrich, another cow of lot II, was taken sick in the same manner as Alma. After she was fed salt for a few days she recovered. As the period of time in the experiment advanced, more and more cows of lot II took sick; in every case upon the addition of salt they recovered.

Sickness caused loss in flesh and diminished the milk flow. There was only one cow that completed the whole year without salt. Her period of no salt was, therefore, continued for three months more. She continued in apparently good condition until just before calving and after calving she died.

Dr. Babcock concludes that it is possible to hold a cow without salt for two months under conditions existing in Wisconsin. After that time the vitality of the animal is impaired. If calving occurs after the cow has been deprived from salt for a considerable period of time, there is danger of a sudden collapse. This brings out very strikingly the importance of salt for pregnant animals.

Comparing the quantity and quality of milk in the two lots, Dr. Babcock points out that lot I gave a total of 47,531 pounds of milk, lot II, 45,659 pounds. Commenting on these figures, Dr. Babcock states: "The data presented give no evidence that the yield of milk is influenced in any way by giving salt to the cows." The writer feels puzzled by this statement. It is true we cannot dispute figures, but even then a little analysis of the experiment and figures will be taken up and commented upon. First of all we notice that every cow of lot II got sick after a certain period. Sickness is usually the culmination point of gradual accumulation of disturbances. Thus the cows were not normal at all times of the experiment. Still they produced nearly as much as the cows of lot I. The individual characteristics of the cows kept up their record and if salt would have been supplied, lot II would have exceeded lot I. In the second place we do have an increase of 2000 pounds of milk, or 250 pounds per cow. Dr. Babcock minimizes this increase by stating, that it may be due to individual peculiarities of the cows. The same may be argued in favor of lot II, e.g., the fine showing lot II made without salt is due to individual peculiarities. It seems to the writer that experimenting with one lot of cows only, giving salt at certain periods and then withholding it for a time, would be of greater value.

Dr. Babcock has yet another test. This consisted of a lot of cows which were deprived of salt. No comparisons were made with other cows. The results were the same as in previous experiments: the cows endured the lack of salt for a certain time and

broke down. This was accompanied by a loss in weight and drop in production. It is interesting to note that the Cl content in the milk increased. The reason for this is not given. It does, however, explain the phenomenon mentioned earlier in this paper that milk from unsalted cows sours more quickly. Chlorine is an acid forming element.

Summing up the experiments, Dr. Babcock advises the use of at least one ounce of salt per 1000 pounds weight for a dairy cow, with 0.6 ounces for every 20 pounds of milk.

The Kansas Agricultural College reports "that cattle brought to the college are very greedy for salt. If allowed to satisfy their desire, they will consume so much that it greatly deranges the process of digestion. After the cattle become accustomed to the salt, it can be kept before them at all times with no bad results." In the Kansas herd salt is supplied in boxes under the sheds and replenished as often as necessary. The salt is weighed out in 2-pound bags for ten or twenty cows, and this amount is placed at a time so as to keep the supply fresh. Only barrel salt is used, rock salt being coarse and having an irritating effect.

The Kansas Station reports the amounts of salt used by calves. It also gives the kinds of feed.

NO. OF LOT	NO. OF HEADS IN LOT	KIND OF FEED	AMOUNT OF SALT USED UP
			<i>pounds</i>
1	20	Shelled corn and alfalfa hay.....	36
2	20	Kaffir corn and alfalfa hay.....	42
3	20	Shelled corn, $\frac{1}{3}$; soy beans, $\frac{1}{3}$; prairie hay, $\frac{1}{3}$...	50
4	20	Kaffir corn, $\frac{1}{3}$; soy beans, $\frac{1}{3}$; prairie hay, $\frac{1}{3}$	60
5	10	Shelled corn and alfalfa.....	24
6	10	Shelled corn and alfalfa.....	39 { 14 pounds ate at will; 25 pounds fed in feed
7	10	Shelled corn and alfalfa and a condimental feed	12
8	10	Shelled corn.....	34
9	10	Shelled corn.....	16

There were nine lots and the following table will show the amount of salt used with the different feed.

It will be noticed that soy beans and Kaffir corn increase the salt requirements. In case of lot 3 and 4 the increase of 10 pounds is due to the Kaffir corn only. Lot 8 was raised on skim milk, lot 9 on whole milk. It shows that the skim milk ration requires more salt. As a whole this experiment suggests what has already been mentioned, that the salt requirements differ with the kind of feed.

In the introduction the writer says: The idea of this paper is an attempt to review the literature on the subject, to bring forth the modern views, and, if possible, to draw some practical conclusions." Whether the writer succeeded in the first two aims, he refrains from stating; the generous criticism of his readers and hearers is welcome. As to the last aim the following may be stated: salt is one of the important ingredients in the ration. A lack of salt will produce pathologic conditions, bringing forth a loss of flesh, vitality, and consequently a decrease in production. Cows should have free access to salt. Cows should get between 2 and 2.5 ounces of salt, the amounts to vary with the feed. The latter is applicable to stable feeding where the salt is mixed with the feed. As stated in the course of the discussion standards would be welcome.

It may be said in conclusion that more light on this subject is still waited for.

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A COMPARISON OF BACTERIA COUNTS IN WHOLE AND SKIM MILK, SEPARATOR AND CENTRIFUGE CREAM

R. W. LAMSON

*Bureau of Chemistry, United States Department of Agriculture,
Washington, D. C.*

There are two classes of unmanufactured dairy products most commonly found upon the market, namely, whole milk and cream. The former at least is subject to some sort of sanitary supervision by nearly every commission having anything to do with food control work. The basis for their enforcement of such a pure food regulation is usually a standard or tolerance of bacteria per cubic centimeter. In many cases no standard is prescribed for cream, or, if so, it is usually much more liberal than the milk standard. In fact, it is customary to allow from five to twenty times as many bacteria in the cream as in the whole milk.

An extensive study of this subject was made several years ago by the New York milk commission (1.) Their report contains the following: "In 20 per cent cream, the count shall not be more than five times the limit for the same grade of milk." The source of the number "5" is not given, but a study of the literature on this subject reveals the fact that most workers have reported from five to twenty, or more, times the bacteria in cream that there was in the milk from which it was obtained. The reason for this will be explained later.

The tendency to judge the sanitary character of milk products on a bacteria count is sure to increase, hence it is very important that a fair standard of tolerance be established. Many companies are now buying from their patrons on a combined basis of butter fat, and bacterial content, and they are at a loss to know whether or not to make the same limit of bacteria for both milk and cream.

From an extensive observation of the conditions in Canada and Eastern United States, I am convinced that nearly all the

cream on the market is separated from milk by one of the several forms of cream separators. The gravity separation is a method that has generally been discarded, this being equally true of dairies with only a few cows, hence this paper deals with the method in most common use. This fact has an important bearing upon an interpretation of the limited amount of literature on this subject. Dr. Anderson (2) reports the result of a large number of analyses, most of these being made upon cream separated from milk by the gravity method. He also reports results of analysis of cream raised by centrifugal force. In brief, his conclusions are: "Top milk (by gravity method) often contains 10 to 500 times as many bacteria as were in the mixed milk. Centrifugally raised cream [Note: Not commercial separation] contains more bacteria per cubic centimeter than the gravity cream from the same milk." The centrifuge experiment was conducted in a flask or bottle and should not be taken to mean a commercial separator where the separation also depends upon centrifugal force. Scheurlen (3) apparently conducted his experiment by the use of a centrifuge, and he found a marked decrease in bacteria in bottom milk and a marked increase in the sediment and cream. Russell (4) states in his book that separator cream should have no more bacteria per cc. than gravity cream if the separation is done properly. Several other workers have reported somewhat similar findings, and it appears that the results obtained from gravity cream and that separated in a container in centrifuge have been considered to be similar to what might be expected in a commercial separator. Heinemann (5) states that separator cream contains a smaller number of bacteria per cubic centimeter than the whole milk from which it was obtained. In a later work (6) he further states "that the number of bacteria in separator cream decrease proportionately as the fat content increases."

The apparent discrepancy and misinterpretation of results offered the suggestion for the piece of work reported in this paper. The plan of the work was briefly as follows: Total count of bacteria in whole milk, in cream and skim milk separated from this by a commercial cream separator, in cream and skim milk separated

TABLE 1
Bacteria per cubic centimeter in whole milk, cream, and skim milk

SAMPLE		WHOLE MILK	SEPARATOR SKIM MILK	SEPARATOR CREAM	CENTRIFUGE SKIM MILK	CENTRIFUGE CREAM	PER CENT BUTTER FAT IN		CENTRIFUGE	
Laboratory number	Analyst						Separator cream	Centrifuge cream	R. P. M.	Period minutes
14703	L	2,700	4,500	26,850	115,000	180,000	25.45		2,000	20
	R	4,300	3,000	2,000	55,000	110,000				
	N	1,600	2,050	1,050	2,000					
14705	L	11,000	9,300	15,000	700	330,000	13.77	64.32	2,100	20
	R	9,500	7,500	13,750	500	170,000				
	N	9,700	8,950	8,650	150					
14707	L	4,700	3,950	2,900	500	52,500	36.89	65.79	2,100	10
	F	2,250	4,100	8,600	6,800	4,180,000				
	N	3,000	3,900	1,850	100					
14708	L	760,000	315,000	1,280,000	147,000	15,750,000	44.05	64.59	2,100	10
	F	7,550,000	2,750,000	15,900,000	1,150,000	93,600,000				
	S	550,000	300,000	535,000	285,000	13,500,000				
14709	L	12,400	9,300	5,700	600	237,500	40.31	68.76	2,200	10
	N	5,500	11,500	4,700	250					
	S	10,000	7,400	5,500	550					
14712	L	5,450	2,000	5,000	550	82,500	45.28	64.56	2,100	10
	N	9,500	4,300	3,300	500	147,500				
	S	12,800	5,350	3,100	350	103,000				
14714	L	13,500	10,700	12,500	6,500	163,000	54.77	65.86	2,100	10
	N	11,000	10,000	5,250	3,500	16,000				
	S	17,300	11,500	13,600	5,900	126,000				
14715	N	27,500,000	21,100,000	58,300,000	17,500,000	484,000,000	48.76	63.69	2,100	10

COMPARISON OF BACTERIA COUNTS

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14717	L	19,150,000	8,950,000	12,900,000		67.18			
	N	8,700,000	4,700,000	2,810,000					
	S	15,500,000	12,850,000	16,950,000					
14722	L	104,175,000	18,100,000	114,000,000		55.91			
	N	111,000,000	52,500,000	80,500,000					
	F	109,975,000	35,000,000	95,500,000					
14723	L	22,850,000	3,265,000	23,900,000	1,510,000	32.15	64.49	2,100	10
	S	18,000,000	6,800,000	23,700,000	1,950,000				
	N	17,400,000	5,350,000	37,300,000	2,545,000				
14724	L	4,300,000	1,950,000	4,400,000	925,000	30.67	60.44	2,100	10
	S	5,700,000	2,110,000	4,200,000	730,000				
					54,000,000				
					79,000,000				

in a bottle by centrifugal force, and lastly a determination of the butter fat in each cream sample. It was desired to try this on high as well as low count milk, as it was noted that most of previous data were based on relatively low count milk.

In order to eliminate the personal equation as far as possible, at least three analysts examined all but two of the samples in the preliminary studies. Wherever available, the results of the same three analysts are used in the table.

In the first part of this work great care was taken to control the conditions, and this seemed to be justified by the consistent results obtained. The separator parts were thoroughly sterilized before use and put into the machine as aseptically as possible. A large sample, 1 to 2 pints, was collected from the separator spouts in sterile receptacles. For the centrifuge experiment four sterile 250 cc. salt mouth bottles were used. These were covered with sterile parchment paper during the centrifugal process. The cream in each of the four bottles was composited into another sterile bottle. In each case I prepared the analyst's portion in the following manner: the milk or cream was vigorously shaken 100 times with sterile glass shot and portions of about 25 cc. were removed in an aseptic manner and placed in sterile containers; each analyst was given an individual subsample.

The following analysts in the Microbiological Laboratory, Bureau of Chemistry took part in this work and their results are indicated by their initial: Dr. L. A. Round, S. K. Farrar, W. R. North, Jr., D. Soletsky and R. W. Lamson.

Mr. J. T. Keister, of the Food Control Laboratory, Bureau of Chemistry, determined the fat content on all the cream samples.

The results reported represent an average of duplicate plates made on standard plain beef extract-peptone agar-agar incubated forty-eight hours at 37.5°C. except those in table 4, where only the Breed microscopic count was used. All methods are those prescribed by the Standard Methods Committee for milk analysis.

An observation of table 1 indicates that the several analysts agree very closely in their findings, and further that the number of bacteria in the original whole milk did not materially influence the proportions found in the cream and skim milk.

The last two columns give the number of revolutions and length of time of centrifuging for the cream and skim milk separated in centrifuge bottles.

There may be some criticism of these results because of the fact that the separator cream is somewhat heavier than that commonly found on the market. This may be partly true, but the tendency is toward the separation and shipping of relatively heavy cream in order to save transportation and handling charges, because the cream producers are usually those located farthest from the markets. This heavy cream is then modified in final plant to the desired butter fat content, hence the higher percentage cream represents more truly the condition of production and handling.

TABLE 2

Percentage count of each class of the product considering whole milk as 100 per cent

NUMBER	SEPARATOR SKIM	SEPARATOR CREAM	CENTRIFUGE SKIM	CENTRIFUGE CREAM	PER CENT BUTTER FAT	
					Separator cream	Centrifuge cream
14703	107	347	1,997	5,052	25.45	
14705	80	117	4	2,336	13.77	64.32
14707	120	137	74	63,738	36.89	65.79
14708	38	200	18	1,386	44.05	64.59
14709	101	57	5	2,554	40.31	68.76
14712	42	41	5	1,200	45.28	64.56
14714	77	75	38	732	54.77	65.86
14715	77	211	74	1,760	48.76	63.69
14717	61	75			67.18	
14722	33	90			55.91	
14723	27	146	10	629	32.15	64.49
14724	40	86	17	1,330	30.67	60.44

The above percentages represent all counts under each number. The counts of the different analysts were added together and the average of the total count on each sample of whole milk represented 100 per cent. Hence 200 per cent indicates that such a count was twice that obtained on the whole milk. And in like manner 50 per cent indicates that the count was but one-half that found in whole milk. It will be noted that three-fourths of the average percentages for the separator cream are lower or but

very slightly higher than the count obtained on whole milk. It is also interesting to note that the count on centrifuged cream usually averages between six and twenty-five times the total count on whole milk in the same sample. It also appears that the skim milk usually contains considerably less bacteria than the milk from which separated.

TABLE 3

Comparison of per cent of butter fat with per cent of bacteria count in separator cream

NUMBER	BUTTER FAT	BACTERIA
	<i>per cent</i>	<i>per cent</i>
14705	13.77	117
14703	25.45	347
14724	30.67	86
14723	32.15	146
14707	36.89	137
14709	40.31	57
14708	44.05	200
14712	45.28	41
14715	48.76	211
14714	54.77	75
14722	55.91	90
14717	67.18	75

In the above table the results are arranged in order of increasing per cent of butter fat. It may be noted that there is a slight indication that an increase in butter fat results in a decrease in percentage count of bacteria. This is doubly interesting when considered in connection with the counts obtained on the centrifuge cream in which the percentage of butter fat was always 60 per cent or more, and where never less than six times the bacteria of whole milk were found.

In order that these results might more nearly represent trade conditions, the writer, while engaged in milk work in northern New England during the summer of 1917, secured the results presented in table 4. These samples were collected whenever a creamery was visited in which a commercial separator was in operation. No attempt was made to control the conditions of handling, but samples were collected in an aseptic manner from

the whole milk running into the top of the separator, and immediately after similar samples were collected from the cream and skim milk spouts. In this way representative commercial conditions were obtained. Little is known about the cleaning these separators received before being used. The method of analysis for all these samples was the Breed microscopic count, counting groups only. Previous extended studies have indicated that this method, as used by the writer, will approximate the count on plain agar, when applied to the raw product.

TABLE 4

Bacteria counts of whole milk, separator cream and skim milk; Breed microscopic count bacteria per cubic centimeter

PLANT	WHOLE MILK	BACTERIA CREAM	SKIM MILK
A.....	4,000,000	7,000,000	7,000,000
B.....	4,700,000	5,900,000	1,600,000
C.....	15,000,000	27,000,000	16,000,000
D.....	1,200,000	600,000	400,000
D.....	7,500,000	9,300,000	23,300,000
E.....	7,800,000	7,300,000	2,300,000
F.....	5,000,000	14,000,000	4,600,000
Total.....	55,000,000	71,000,000	59,000,000
Average.....	8,000,000	10,000,000	8,000,000

It is to be regretted that more analyses are not available for the above table, but those presented are in agreement with the results obtained in the preliminary studies, namely, that cream should not be judged by a more lenient standard than milk. In only one case was the count on the cream twice that on the whole milk, and in this case the separator was not working properly, having stopped two or three times previous to taking these samples. An average of all the counts shows the cream to have but 25 per cent more bacteria than the milk from which separated, and this figure is well within the limit of error.

The writer's experiences during the past three years have shown that it is easily possible for large lots of bulk cream to be marketed with counts of much less than 1,000,000 bacteria per cubic centi-

meter. In most cases this represented the mixed product from a large number of dairies, none of which are above the average in sanitary efficiency. Thus it is seen that we are dealing with a commercial possibility; and in fairness to the producer of whole milk it is suggested that cream standards be not made more lenient than those for whole milk, unless those making such standards have conclusive analytical data that such is a fair arrangement. The writer is satisfied that a uniform standard is commercially desirable.

SUMMARY

These results indicate quite strongly that there are usually less or only slightly more bacteria in separator cream than in the whole milk from which separated. Also that centrifugally raised cream in closed container showed from six to twenty-five times as many bacteria as were found in the original milk.

The skim milk usually contained fewer bacteria than the whole milk.

There does not appear to be any sharp relation between increase in butter fat, at least above 25 per cent, and the percentage of bacteria found in the cream.

These results for separator cream are in quite close agreement with the findings of other investigators who actually worked on separator cream. The results obtained on centrifuge cream are also very similar to those reported by other writers on this class of product.

The comparison between the two types of cream from the same whole milk indicates that it is erroneous to interpret the results on centrifuge cream as comparable to what would be found in commercial separator cream.

From this and other investigations on commercial separated cream it would appear desirable to have a common bacteriological standard for market whole milk and cream.

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PRODUCTION OF ACID PHOSPHATE FROM CREAM- ERY WASTE SULPHURIC ACID

R. H. CARR

Purdue University, LaFayette, Indiana

During the existence of the unsettled state of affairs caused by the present war, anything which tends to conserve or increase our munitions and our food supply commands the attention of all thoughtful people. Since the outbreak of the war, the demand for sulphuric acid, which is very great even in time of peace, has been greatly increased. This increase has caused an increase in the price of acid phosphate as well as a scarcity of it and this will in turn cause a decrease in crop yield because it will interfere with its continued use as a fertilizer. The need for both the acid and the phosphate led the writer to make in Indiana some investigations of the waste acid connected with the dairy industry with a view to the possible utilization of this waste to increase our production of acid phosphate and to cause a consequent saving of our acid for explosive manufacture.

AMOUNT OF SULPHURIC ACID USED

Requests were sent to ten of the large dairy plants concerning the amount of sulphuric acid used in their fat testing work and returns show that an average of 4000 pounds of acid were used by each company per year. One company reported using 40,000 pounds during the past year. Although the survey was far from complete, enough data were obtained to show the possibilities of further use of the sulphuric acid in making enough acid phosphate to materially increase crop production if it could be utilized. The amount of acid used in the fat test varies considerably with the temperature and richness of the cream and with the different testers as the amount of acid to be added is determined, by the degree of blackening or charring produced where the acid is added to the cream to be tested (from 8 cc. to 12 cc. of 1.83 acid is used).

But on the whole the analysis of mixture of cream and acid after the tests were completed and fat removed had approximately the following composition.

Percentage composition of waste acid

	<i>per cent by weight</i>
1. (H_2SO_4) sulphuric acid sp. gr. 1.200.....	27.32
2. Nitrogen (Ammono acids, peptones, etc.).....	0.054
3. Ash (potassium and calcium, etc.).....	0.11
4. Volatile organic matter.....	0.56
5. Sugar (lactose).....	0.525

METHOD OF MANUFACTURE

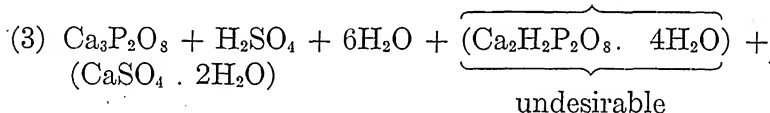
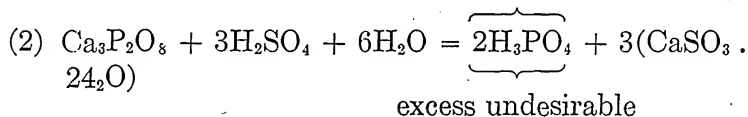
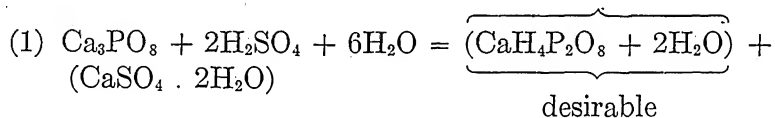
It has been found desirable in making acid phosphate from rock phosphate to use 60 per cent acid instead of the concentrated because water is necessary in order to form a hydrated calcium sulphate, also a hydrated mono-calcium phosphate. Since a 60 per cent acid is needed instead of 27.32 per cent as shown in analysis, it would seem a simple matter to concentrate the waste by passing the waste steam of the creamery through a lead coil contained in an acid proof jar with an outlet at the bottom to draw off the concentrated acid into a carboy and also one near the top to draw off the fat. This waste fat somewhat purified by live steam treatment has a market value of about fifteen cents per pound and in the case of the one company mentioned the fat from this source amounts to nearly 35 pounds a day. This fat should not be permitted to go to waste. A lead coil and jar suitable for many plants should not cost more than \$15. Other devices for concentrating the acids may be employed as conditions seem to justify. The concentrated acid could be mixed with the ground rock phosphate in a cement mixing box (wooden) and after the first reaction is over (few hours) could be shoveled into bins to "ripen," thus avoiding any further expense. Usually the highest grade rock obtainable is used (78 per cent to 80 per cent calcium phosphate) and it is ground to pass an 80 mesh sieve. It is usually mixed in the proportion of 1 pound of rock to 1 pound of 60 per cent acid,

giving a yield of about 1.9 pound of acid phosphate, the loss (about 10 per cent) being partly due to evaporation of water caused by the heat of reaction and the subsequent drying.

CHEMICAL CHANGES INVOLVED

The amount of acid used in comparison with the rock is a matter of much importance and to get the *highest efficiency* it should be controlled by a chemist. If too much acid is used there is a tendency to form an excess of free phosphoric acid. This attracts moisture from the air and makes the fertilizer lumpy. If too little acid is added there is a tendency for the acid phosphate to revert to the di-calcium phosphate which is less water soluble.

Reaction:



The writer finds that the sugar is mostly carbonized on concentrating the acid to 60 per cent and if diluted some of the carbon will settle out. However, the 60 per cent acid retains most of the carbon in suspension or colloidal solution which gives it a black color. The carbon seems to be of some advantage to the acid phosphate as it tends to keep the mass granular and porous. The other impurities in the acid are compounds of nitrogen, calcium, potassium, and phosphorus. They are in water soluble form and are an advantage to the fertilizer. The percentage of these constituents in 60 per cent acid are more than double the amounts given in analysis due to greater concentration. The acid phosphate manufactured from the waste acid had approximately the following composition:

Percentage composition of fertilizer

Potassium sulphate.....	0.357
Acid phosphate.....	14.000
Nitrogen as (NH ₃).....	0.232
(present as amino acids)	

Figuring these in pounds per ton we obtain 7.14 pounds of potassium sulphate, 122 pounds of acid phosphate, 4.64 pounds of nitrogen expressed as ammonia. Thus it will be noted that the impurities in the acid are of value to it in the manufacture of this fertilizer.

PHOSPHORUS DEFICIENCIES IN SOILS

Phosphorus is the plant food element most deficient in the majority of our soils, it being one of the important ones removed from the land by the sale of many farm products, grains, milk, livestock, etc. and thus it is lost to further crop production. It requires about 23 pounds of phosphorus to grow 100 bushels of corn or 1 pound of phosphorus for 4.35 bushels. At this rate the acid now wasted by the 10 companies referred to would be sufficient, if it could be utilized, to furnish phosphorus to raise 32,276 bushels of corn.

CONCLUSION

In conclusion it may seem that the amount of acid phosphate that might be produced at any one place is not large compared to the output of a factory producing 350,000 tons per year, yet when one considers the amount of fertilizer possible to make over the whole United States from this waste acid with no appreciable additional expense, it would certainly seem to be worth while. Again the fact that acid phosphate made in this way carries enough nitrogen and potassium to make it worth several dollars more per ton than the usual product upon the market is additional evidence in its favor. Hence, it would seem that both the acid and the fat are too valuable products to be poured down the sewer while acid phosphate is becoming scarcer and higher in price.

A STUDY OF THE EFFECT OF COTTON STOPPERS USED IN DILUTION BLANKS ON THE NUMERICAL BACTERIAL COUNT, AND OF OTHER PRACTICES IN THE TECHNIQUE OF BACTERIOLOGICAL LABORATORIES

ROY S. DEARSTYNE

City Health Department, Baltimore, Maryland

In bacteriological laboratories where large quantities of dilution blanks are in daily use, the question of the actual effect of the use of cotton stoppers in such blanks on the numerical bacterial count has become a matter of such moment that it was decided to investigate this matter in order to learn if the detrimental effect of these stoppers was such as to cause the discarding of this style of blank, and the adopting of the glass stoppered bottles—a step which would necessitate a large initial expense and a continued additional expenditure for handling and upkeep.

Our winter schedule of milk and water analysis necessitates the use of 600 six-ounce water blanks and 1100 one-ounce water blanks weekly, while during the summer months, approximately 1100 large and 600 small blanks are used. From the number used, the large amount of handling this glassware receives can be seen, and besides the expense, double sterilizing, cleaning room, and cabinet space would be needed, because in order to handle the glass stoppered blank successfully, each stopper should be chained or wired to its respective blank. Hence, we believe that the investigation of this phase of our work was necessary, and think that the results obtained warranted our work in this line.

In this experiment, 100 samples were used, and the following technique was employed—a sterile 99 cc. water blank was inoculated with 1 cc. of milk, and was rotated until the fluid seemed fairly uniform, care being taken not to allow this fluid to come in contact with the stopper. From this blank, 1 cc. was inoculated into a sterile petri dish marked "1A." The blank was then shaken twenty-five times as required by Standard Methods of

Milk Analysis, and 1 cc. was placed in a sterile petri dish marked "1B." The stopper of this blank was then taken, and with sterile paper, the fluid retained by the stopper was forced into a small sterile blank, and 1 cc. of this fluid was inoculated into a sterile petri dish marked "1c." These three dishes were inoculated with approximately 10 cc. of nutrient agar, and incubated for forty-eight hours at 37.5° C., and it is on the results of 100 such series that our conclusions are founded.

Calling the inoculations made from the rotated sample "A," the same sample shaken "B," and the exudate from the stopper of this shaken blank "C" we have the following results:

Aggregate total "A"—100 samples actual count.....	9876
Aggregate total "B"—100 samples actual count.....	9069
Aggregate total "C"—100 samples actual count.....	7969
Excess count of "A" over "B"—aggregate.....	807
Excess count of "A" over "C"—aggregate.....	1907
Excess count of "B" over "C"—aggregate.....	1100

In the series of 100.

"A's" count was highest 56 times
"A's" count was 2nd highest 35 times
"A's" count was 3rd highest 9 times
"B's" count was highest 34 times
"B's" count was 2nd highest 48 times
"B's" count was 3rd highest 18 times
"C's" count was highest 10 times
"C's" count was 2nd highest 17 times
"C's" count was 3rd highest 73 times
The average count of "A" was 98.8
The average count of "B" was 90.7
The average count of "C" was 79.7

These averages would tend to show that in every 100 organisms per cubic centimeter there is lost by shaking the blank approximately 8 organisms which adhere to the stopper or 8 per cent. If the stopper drains dry, or is compressed to lose all its moisture, there still is retained around 20 organisms per 100 or the amount shaken, and the results show that the exudate given off by the stopper contains less bacteria than the fluid shaken against it.

To prove that the strands of cotton retain the organisms, in 25 cases, these strands from the compressed stoppers were picked

under sterile conditions, inoculated into melted agar tubes, and plated out. In each case, after forty-eight hours incubation at 37.5° C., the plates showed innumerable colonies growing along the strands of picked cotton.

Regarding the general impression that cotton stoppers increase the count by lessening the dilution, we would state that we consider this factor almost negligible, inasmuch as we found in trying to run some experiments on the quantity of the dilution retained, that if the blanks stood for two minutes or less, that it was almost impossible to secure a cubic centimeter, and that the inconsistency of the stoppers was such as to preclude accurate work on this phase.

On the basis of the work done, this department has deemed it advisable to eliminate the cotton stoppered type of blank and adopt the glass stoppered type.

DOES *B. SUBTILIS* OR OTHER SPORE-BEARING ORGANISMS IN THE
CENTER OF COTTON STOPPERS SURVIVE HOT AIR
STERILIZATION?

The frequent appearance of *B. subtilis* on agar plates in our routine work led us to investigate as to whether or not this organism survived our sterilization temperature, 200° C., for one hour. In this investigation strands were picked under sterile conditions from the center of cotton stoppers which had been sterilized, and were immersed in melted agar tubes. These tubes were plated and incubated for forty-eight hours at 37.5° C.

Of the 30 stoppers picked, 24 proved to be sterile; 4 had 1 colony; 1 had 3 colonies, 1 had 4 colonies, and 1 was contaminated. This investigation was not continued further, as the results show that as far as routine work is concerned, this phase of the cotton stopper question was acceptable.

THE AGITATION OF ORIGINAL PACKAGES OF MILK BY HAND IN
ORDER TO SECURE AN EVEN BUTTER FAT DISTRIBUTION
FOR TAKING A BACTERIAL SAMPLE

Owing to the lack of a satisfactory mechanical agitator for original packages of milk, our technique in preparing these pack-

ages for the taking of a bacterial sample consists of thoroughly shaking these bottles with the cap both up and inverted. In order to ascertain if the butter fat was evenly distributed, and that the sample taken was fair in every way, fifty of these packages were run for butter fat content in the following manner:

The samples were shaken in the customary manner and 17.5 cc. was taken from the zone of our 1 cc. delivery pipette, and another 17.5 cc. taken about a half inch from the bottom of the bottle, and Babcock tests for butter fat were run on these samples. The following results were obtained, calling the top portion zone "1" and the bottom zone "2."

PER CENT DIFFERENCES	TOTAL	ZONE 1—HIGHEST PER CENT BUTTER FAT	ZONE 2—HIGHEST PER CENT BUTTER FAT
0.00	13	—	—
0.05	4	2	2
0.10	8	6	2
0.15	3	1	2
0.20	7	7	—
0.25	1	1	—
0.30	5	3	2
0.35	1	1	3
0.40	4	1	—
0.50	2	2	—
0.60	1	1	—
0.70	1	—	1

These samples represented every type of capping on the market and included samples where there was little or no space between the cap and milk line as well as those with a fairly large space.

We conclude that this manner of agitation gives a representative sample, and is fair to all concerned.

A STUDY OF THE PROPAGATION OF BACTERIA IN GLASS AND IN PAPER CONTAINERS

Testing out the assertion that bacteria would not propagate rapidly in patent paper milk containers as in the commonly used glass bottles, a series of experiments was carried out on this question.

Five duplicate samples were placed in both the glass and paper bottles and these were subject to the following temperatures,—50° F. (2); 35 to 40° F.; 68° F.; and room temperature. Counts were run at as regular intervals as possible for three days, using the technique of the Standard Methods of Milk Analysis."

The results of these experiments show that there is practically no difference in the propagation in the different containers.

FIELD SURVEYS AND DAIRY MARKETING INVESTIGATIONS¹

L. M. DAVIS

Bureau of Markets, Washington, D. C.

The subject of field surveys and dairy marketing investigations as conducted by the Bureau of Markets, United States Department of Agriculture, is, to some extent, a comparatively new line of work. Although the terms "survey" and "investigation" imply the same character of work, the Bureau of Markets in its Dairy Section has recognized a distinction, and has adopted the use of the term "survey" when speaking of studies or investigations of producers' marketing problems, and the term "investigation" when the studies pertain to problems of market distribution. With this rather arbitrary distinction in mind, the various phases of field surveys and later those pertaining to marketing investigations will be discussed.

THE PURPOSE OF DAIRY MARKETING SURVEYS

It is generally recognized that the profitable production of dairy products is closely related to their efficient and economical marketing. The recent efforts of milk producers in many sections of the United States to improve their milk marketing conditions and methods have resulted in the organization of milk marketing associations for the purpose of pooling their product for sale. Some associations have provided facilities for manufacturing their milk or cream into butter, cheese, or other dairy products, while others have undertaken the ultimate distribution of market milk to consumers through the establishment and operation of a city milk distributing plant.

The type of an organization which will best serve the dairy interests of a community, the marketing facilities which should

¹ Paper presented at the Dairy Marketing Conference held at Columbus, Ohio, October 23, 1917 during the National Dairy Show.

be provided, and the arrangements which should be made for the sale of the surplus product, are matters which are usually contingent upon local conditions and the markets which are available. A casual inquiry relative to the local conditions and the available market outlets is often an insufficient basis upon which to determine the type of organization or the facilities which should be employed. So important are these factors that a careful survey must be made of the marketing conditions existing both within the producing territory and in the markets where the products are to be sold before a definite decision can be reached regarding the best methods of solving a community's dairy marketing problem.

SCOPE OF DAIRY MARKETING SURVEYS

Whether a private individual, a corporation, or a cooperative organization of milk producers is to provide the marketing facilities and the marketing arrangements for the sale of a community's dairy product, it is essential that certain facts be established in order that the marketing conditions may be carefully analyzed and the success of the proposed marketing venture may be assured.

Obviously, the available supply of product to be marketed is an important factor to be determined, inasmuch as definite plans for manufacturing and marketing are dependent upon information regarding the amount to be handled. A second important factor to be determined is the disposition which is made of the milk or cream produced in the community or territory concerned, for under ordinary conditions it would be unwise to undertake the operation of a butter factory in a section where a sufficient supply of milk and cream could not be obtained to make a creamery a commercial success, or in a section where the production of market milk for city distribution had been highly developed. Likewise, other possible or competitive outlets of sale, such as cheese factories and condensories, should be considered. All of these are most important factors, because the first requirement of a dairy plant, no matter what the product handled may be, is

the supply of raw material. Many failures of cooperative organizations are traceable directly to the fact that an outside party whose interests were largely personal promoted the organization by selling stock in the needed building and equipment, and who, after getting his money, left the association with a plant full of equipment but located in a territory where the local production was too low to support the enterprise. If a survey shows that the available supply is insufficient to warrant the establishment of a local plant, the most logical action to take may be the organization of a cooperative association for the pooling and shipping of the product.

A very important and essential part of a dairy marketing survey where a cooperative dairy marketing organization is proposed is that of determining the spirit of cooperation among the producers and the presence of local leadership. Every local cooperative movement requires local leadership and without it the success of such an undertaking is more or less doubtful. Coordinate with the need of local leadership, there should be present among the producers or prospective organization members a spirit of true cooperation—a willingness to work together for mutual benefit. It is desirable, therefore, that the prospective members pledge not only to give financial assistance in securing the necessary capital, but also to furnish the product of their dairies to the association, as the latter is fully as important as the former for the successful operation of a cooperative marketing association. The possibility of obtaining satisfactory market outlets and the employment of a successful marketing system are other important factors to be considered, for frequently the type of organization, the capital invested and the method of business operation are dependent upon the methods of marketing to be employed.

Last, but not least, as an important part of a dairy marketing survey is a consideration of the practical and feasible form of business organization. Particularly is this important as it involves the methods of financing, the incorporation of the association, and the adoption of the proper form of constitution and by-laws governing business operations. The provisions of state

laws under which the organization may be incorporated as a capital stock, or a non-stock, non-profit organization, are governing features, limiting the membership in some states to actual farmers. Often it is desirable before determining upon any particular type of an organization to note the organization plans, form of incorporation and business methods of associations doing a similar business as that proposed, as suggestions may frequently be obtained which will be helpful in perfecting the proposed organization.

METHOD OF PROCEDURE IN CONDUCTING DAIRY MARKETING SURVEYS

The methods of procedure in conducting a dairy marketing survey will largely depend upon the purpose and extent of the survey and the available forces which may be used in conducting it. The local survey where a milk distributing plant is being considered must necessarily differ from a survey which embraces a wider territory. Various agencies, such as the county farm bureaus, certain trade and commercial organizations, or even public-spirited citizens may take the initiative in organizing the work, but the individual farmer must give a certain amount of assistance if the work is to be of maximum value. With the organization of county farm bureaus and the employment of county agricultural agents, a survey embracing a study of the dairy marketing problem in a county may be directed by the farm bureau agent. Such a survey is comparatively easy to make, for the farm bureau as an association is interested in improving agricultural conditions, of which the marketing of the farmer's products is not the least important. The county organization is usually composed of local community units, each having officers who are familiar with local conditions and who are acquainted with many of the farmers in the immediate community. Through this machinery, either by the use of a questionnaire or otherwise, it is possible to obtain the desired information from the leading farmers in every community in the county. Such surveys were made by the Bureau of Markets in Windham County, Connecticut, and Sussex County, New Jersey, and the

county agents in those counties who coöperated in the making of the surveys found the information which was secured of value to them. Dairy marketing surveys, however, need not be confined to single counties, for under the leadership and direction of the state authorities it is possible with the coöperation of the various county farm bureaus in the state to coördinate the separate county reports and summarize conditions for the entire state. Such a survey was made by the Bureau of Markets in coöperation with the Extension Division of the New Hampshire State College in the early part of this year. A report of this survey was published in July, 1917, as Extension Bulletin No. 8, and persons interested in securing copies of the report may do so by addressing the Extension Division, New Hampshire State College, Durham, New Hampshire. In this publication consideration is first given to the extent of dairy development and the natural conditions which favored the industry in that state. Then the present trend of agriculture is considered, with a discussion of the factors which have lent their influence in reducing dairy production. The facilities, methods and costs of transporting milk to the larger city markets are treated in connection with milk marketing contracts and prices. The dairy and creamery butter industries in the state are reviewed in connection with the possibilities of developing local markets. The opportunities as well as some of the advantages of coöperative organization of milk producers are pointed out as they relate particularly to existing dairy conditions. No attempt is made in this publication to offer definite suggestions as to how needed improvements should be undertaken, the sole purpose being to present fundamental facts regarding conditions which were found to exist. The summary made mentions the following factors as having had an influence upon the past development of the dairy industry in New Hampshire:

1. The use of scrub bulls or bulls of the beef breeds which have been generally unprofitable for specialized dairy purposes.
2. The failure of dairy farmers to give attention to the improvement of their herds, particularly along lines of more economical production.

3. The general development of markets for whole milk, which made the conditions for the rearing of dairy stock less favorable.

4. The uncertainty surrounding the making of contracts for the sale of whole milk caused by the systems employed in the past.

5. The monopolistic conditions afforded by the leased-car system of transportation which made rather prohibitory the shipment direct to city customers of milk or sweet cream by country organizations of producers operating their own plants.

6. The supplying of the summer boarder trade which encouraged summer rather than winter dairying as the prevailing system, with the result that dairying often became a side line rather than a regular or major phase of the farming operations.

7. The inability of the farmer to compete with the manufacturing industries in the employment of labor.

8. The lack of community interest in the permanent solution of the dairy marketing problems, as well as other agricultural problems.

9. The failure of the state to assume fully its responsibilities in affording to the dairy farmers advice and assistance in improving dairy marketing conditions and methods.

State dairy marketing surveys are now being undertaken in Vermont and in Colorado, where state marketing agents are stationed. A number of other states where marketing agents are located have already recognized the importance of their dairy marketing problems, although no systematic work in the nature of a survey has been undertaken.

VALUE OF DAIRY MARKETING SURVEYS

Perhaps the greatest value following the making of a dairy marketing survey lies in the use of the information which is assembled regarding the local marketing situation as it is applied toward improving marketing conditions. It is obvious that information thus gathered is indispensable to the local producers who may be contemplating the forming of a marketing organization, but it may likewise work to their advantage where

such an undertaking is not being considered, for the reason that the more the seller of a product knows regarding the marketing of the product, the more apt he is to obtain the highest market prices. Surveys are highly essential where milk producers are considering the advisability of establishing a creamery, cheese factory, distributing plant, or other dairy marketing organization, and when properly made should also result in creating an interest in the proposed new method of marketing, and serve to strengthen support in it. In a measure, they tend to insure the success of the dairy marketing organization formed as the result of the survey made.

A second advantage is that they create interest in local agricultural development. In almost any community weak points in the system of farming, and particularly marketing, may be found. If these weaknesses can be revealed to the farmers through a survey in which they themselves have had a part, an interest in eliminating these weaknesses, which are usually unprofitable methods and practices, may be developed. The needed improvements may consist of the more extensive growing of certain crops, the keeping of dairy herd production records, or the breeding of more profitable dairy stock. Dairy surveys may also serve to bring dairy farmers to a realization of their common interests, and the coöperative relation thus developed may prove to be of mutual benefit in a business or social way.

The greatest value of a dairy survey, however, lies in the carrying out of the conclusions reached and the deductions made as the result of an analysis of the data and information secured. With a knowledge of all the points embraced in a dairy survey, it is possible to decide with some degree of assurance as to how conditions may be improved, whether it is advisable for the farmers to coöperatively organize and if so, whether the association to be formed should simply maintain a selling agency or whether it should provide facilities for handling and preparing their dairy products for market. Specific data and information is essential to an intelligent understanding and the solution of dairy marketing problems, and it is the purpose of dairy marketing surveys to furnish such information. When dairy

farmers join in an organized effort to make their business more profitable, not altogether through merely securing higher prices under existing conditions, but by ascertaining whether they are supplying the most profitable markets with their product, and if not, learning where such a market is and what such a market wants as to quantity and quality, then furnishing both, the primary purpose of the dairy marketing survey will have been accomplished.

DAIRY MARKETING INVESTIGATIONS

As previously stated, the term "dairy marketing investigations" is used by the Bureau with reference to studies pertaining to problems of market distribution, and includes such phases of dairy marketing as the methods and costs of preparing dairy products for market; facilities for and cost of transporting and storing dairy products; market quotations and quotation systems for dairy products; market requirements; market conditions; marketing agencies; marketing systems and methods and expenses of marketing and distributing dairy products and dairy substitutes; the relation of cost and selling price of dairy products to their quality, grade, or classification and market quotation; the relation of supply, demand, and price of dairy substitutes to the supply, demand, and price of dairy products and vice versa; the channels of trade for marketing; the basis of trading; the relation of the supply of the various grades to market prices and quotations; the effect of import and export trade in dairy products and dairy substitutes upon market conditions, market quotations and prices; and economic factors which influence the demand and supply, as well as the market value of dairy products. All investigations of the various phases of the marketing and distributing of dairy products made by the Bureau are conducted in accordance with general outlines which have been previously formulated and which include, in as much detail as possible, the various important points which should be embraced within the investigation.

In connection with the drafting of an outline of an investigation, a plan of procedure to be followed in securing the desired

data and information is also formulated. With a written outline of the investigation and the procedure to be followed definitely agreed upon, it is possible in conducting marketing investigations to secure the essential data and information desired without loss of time or effort in conducting the work. In accordance with this plan, the Bureau of Markets has completed a number of dairy marketing investigations and has published reports covering a number of them. Among those investigations which have been made and reports issued, the following may be mentioned: An investigation of the markets for creamery butter in the Southern States and an investigation of the marketing of creamery butter in the United States. A report of the former investigation is contained in Circular No. 66 of the Office of the Secretary, entitled: "Suggestions for the Manufacture and Marketing of Creamery Butter in the South;" and a report of the latter investigation is contained in Department Bulletin No. 456, entitled: "Marketing Creamery Butter." Other investigations which have been made, but reports of which have not been published, include an investigation of the marketing of cheese in the United States and Canada, an investigation of milk marketing at Detroit, Michigan; an investigation of the marketing practices of the creameries of Wisconsin and Minnesota; an investigation of the relation of quality to price in the marketing of creamery butter; an investigation of milk marketing in New York State; and a general investigation of the marketing of milk in the United States. Besides these specific investigations, various other minor investigations of different phases of dairy marketing have been included in the investigational work of the Bureau. What is believed will be a most valuable bulletin and which deals with the organization, construction and operation of country milk stations, has been prepared for publication in coöperation with the New York State College of Agriculture.

Importance and value of dairy marketing investigations. As the purpose of dairy marketing surveys is primarily that of furnishing the necessary information for an analysis and a better understanding of producers' marketing problems, so dairy marketing investigations have for their object the analysis of dairy marketing and

distributing methods and conditions. The present methods of marketing and distributing dairy products have been developed largely to meet the needs of certain marketing conditions, and the fact that these marketing conditions as well as methods employed are steadily undergoing a process of evolution and change suggests that they are not necessarily the most efficient and economical. There is need, therefore, for a great deal of investigational work in dairy marketing, not only by the federal government, but by others in order that the existing methods be studied in the light of existing conditions, and that suggestions may be offered and measures taken to effect an improvement in the present systems whereby the costs of marketing and distributing may be reduced.

The activities of the Bureau of Markets relating to the marketing of dairy products have been in progress approximately three years, and while it has been impossible during this time to establish very many concrete results, the work has progressed to the point where definite plans have been made for increased activities in the future. With adequate appropriations to carry on the work, it is hoped that through the field surveys, dairy marketing investigations and dairy extension activities of the bureau, constructive suggestions may be offered and progress may be made in the solution of some of the dairy marketing problems in the United States.

ABSTRACTS AND REVIEWS OF DAIRY LITERATURE

Dairy Cattle Feeding and Management. C. W. LARSON AND FRED S. PUTNEY. New York, John Wiley & Sons, 1917.

A valuable service has been rendered dairy instructors and students as well as others interested in the feeding, care and management of dairy cattle in the publication of this thorough and up-to-date treatise. The book is prepared in a very attractive form being printed on paper of excellent quality which renders very clear and distinct not only the text but the decidedly helpful illustrations which have been carefully chosen to enhance the value of the textual material. The subject matter is conveniently divided into lectures and a full list of references is appended to each.

Before taking up the practical phases of feeding, the authors discuss in detail the principles of nutrition of dairy cattle, including digestion and metabolism, and outline briefly the development of feeding standards. Modern methods of balancing rations are treated thoroughly as well as the selection of feeds. A table of analyses of feeding stuffs conveniently arranged for ready reference is contained in the appendix. The influence of recent investigations in animal nutrition on feeding problems has not been overlooked.

The feeding and care of the young stock and herd sire are thoroughly treated, together with the general management of the herd, fitting dairy animals for show and the principles of breeding.

Some features of especial interest and value which hitherto have had but little attention in a text book dealing with milk production, are found in the latter part of the book. One of these is the lecture dealing with the feeding and management of cows during advanced registry tests. Another is the inclusion of a set of practicums which will greatly aid instructors in preparing laboratory exercises. The most valuable feature, perhaps, is the presentation of the principles and methods used in determining the costs of milk production. In view of the increasing interest in this subject, this discussion is, indeed, opportune.—W. B. N.

Productive Dairying. R. M. WASHBURN. Philadelphia, Pa., J. B. Lippincott Company.

In this book which is intended largely for use as a text book in sec-

ondary schools and as a handbook of information for students and farmers, the author presents in an attractive and logical manner a wealth of material covering the productive phases of dairying.

After discussing in the introductory chapters some of the advantages and benefits of dairy farming, the history, characteristics and type of the various dairy breeds are then fully treated. The practical phases of the care, feeding and management of the dairy herd, the approved methods to be followed in the production and handling of clean milk, together with the standards and rules for the production and distribution of certified milk are treated in a masterly way.

The author does not confine himself strictly to those phases of dairying dealing with the production of milk, but includes a discussion of the manufacture of various dairy products on the farm, the disposition and standards for market milk, and not least in importance by any means, the food value of milk.

A list of questions, which will aid the student in reviewing the subject, is appended to each chapter.—W. B. N.

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